MECHANICAL ENGINEERING

· JUNE 1949 ·

Departments

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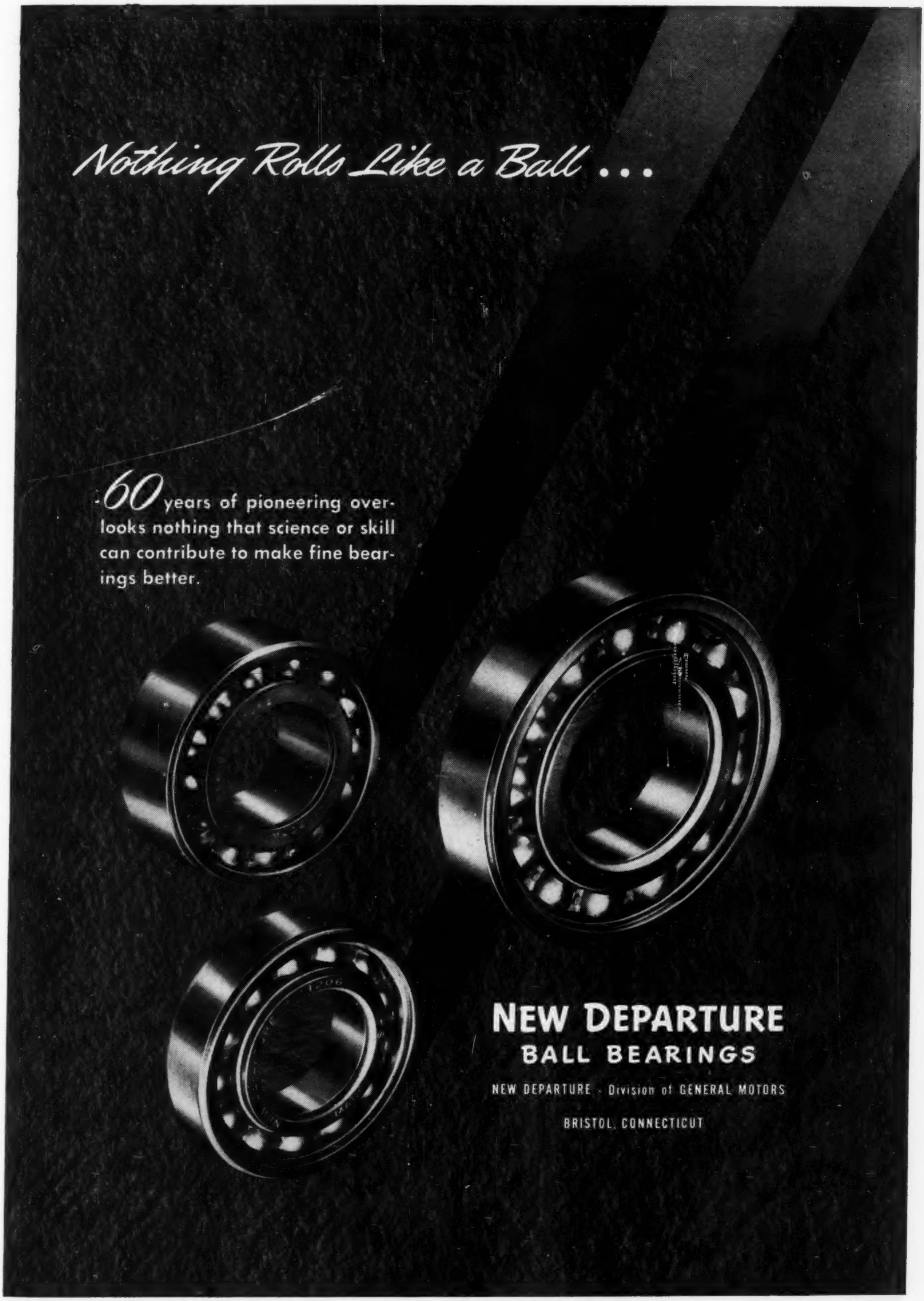

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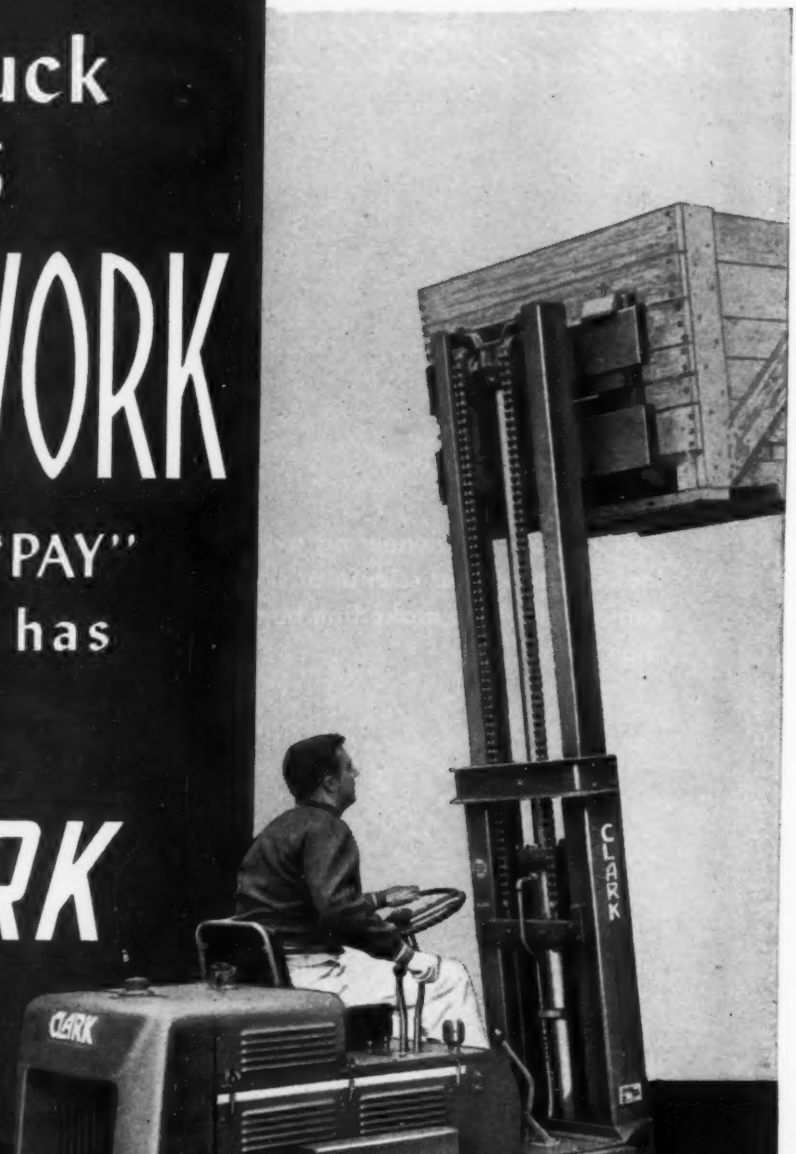

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FROM high quality, close tolerance "ground all over" Precision Ball Bearings. . . . .

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We design and manufacture *"every type and size"* of Gear and Speed Reducer . . . This fact is *important* because: (1) It assures the purchaser of our "unbiased" recommendations; (2) Permits ordering from "one source" of supply; (3) Enables the purchaser to place the *responsibility* for the operation of their Gears and Speed Reducers upon the shoulders of "one manufacturer."

Your inquiries are invited for information on any type of Gear or Gear Driven Product which includes the widely used *"Limitorque" Motor-Operated Valve Control.*

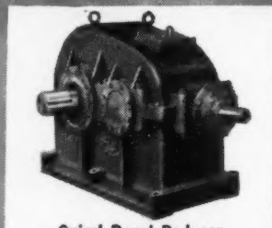
Send for catalog on any product, and please use your Business Letterhead when requesting same.


Herringbone Reducer

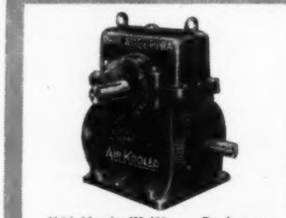

Vertical Worm Reducer


Worm Reducer

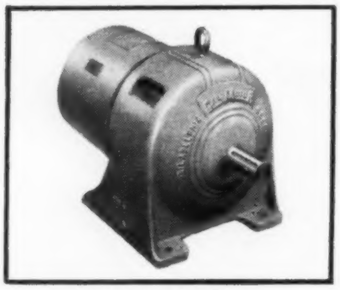

Limitorque Valve Operator

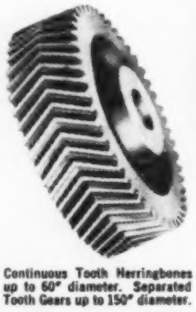

Spiral-Bevel Reducer


Planetary Reducer

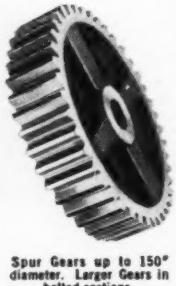

"AirKooled" Worm Reducer


Vertical Motor Reducer


Philadelphia GearMotoR


Continuous Tooth Herringbones up to 60" diameter. Separated Tooth Gears up to 150" diameter.


Worm Gears up to 150" diameter. Worms to match.


Spur Gears up to 150" diameter. Larger Gears in bolted sections.

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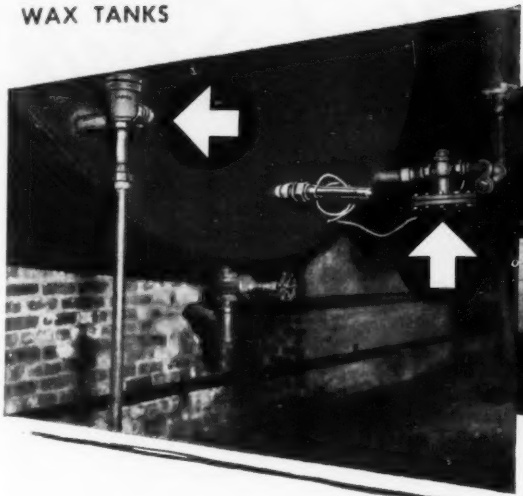
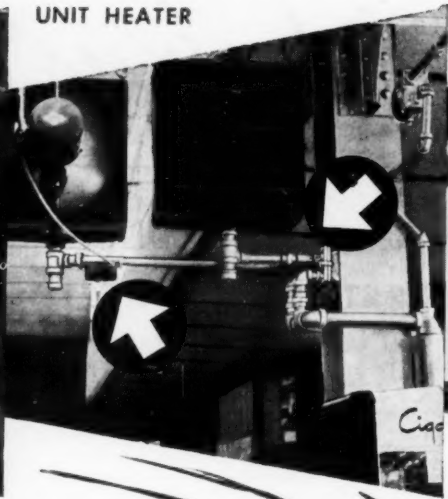
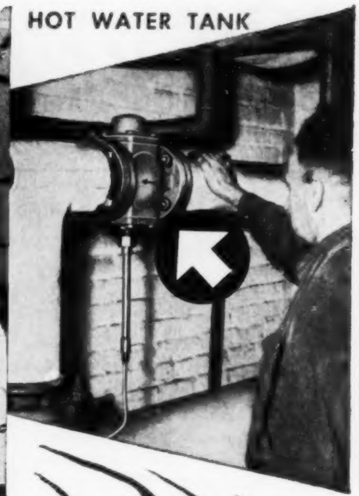


UNIT HEATER



HOT WATER TANK



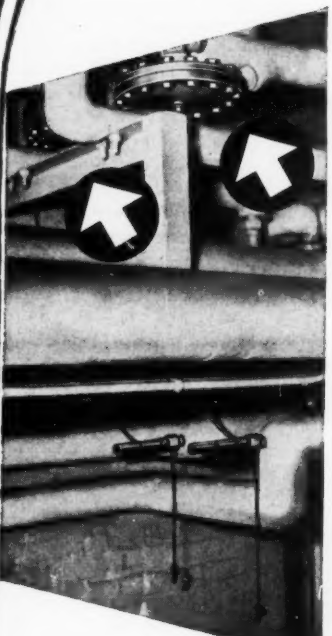
HOW SARCO SAVES FUEL

"I've been paying for Sarco Steam Traps and temperature controls for years in wasted heat. Thought I might as well have them and the other advantages too."

This statement was made by executives who knew the facts, but just "never got around to it."

Take the wax tanks illustrated. Tons of hot wax are stored, and poured into 100 lb. paper bags for shipment. Too cold—it won't run. Too hot, it burns or ruins the bags and wastes heat. The Sarco No. 9 Steam Trap at the left extracts all usable heat in the steam coils before it lets the condensate go. The Sarco Control at the right, holds the temperatures within a degree—and again, saves steam.

Unit Heaters start and stop at the command of Sarco Electric Controls. Hot water is held at correct temperatures in converters and tanks, or blended for wash water. Even fuel oil preheat is exact when an All-Sarco job is installed. These savings and many more are available through the Sarco Representative near you. Ask for Catalogs applying to your special conditions.



FUEL OIL PREHEATER

SARCO
SAVES STEAM

232

SARCO COMPANY, INC.
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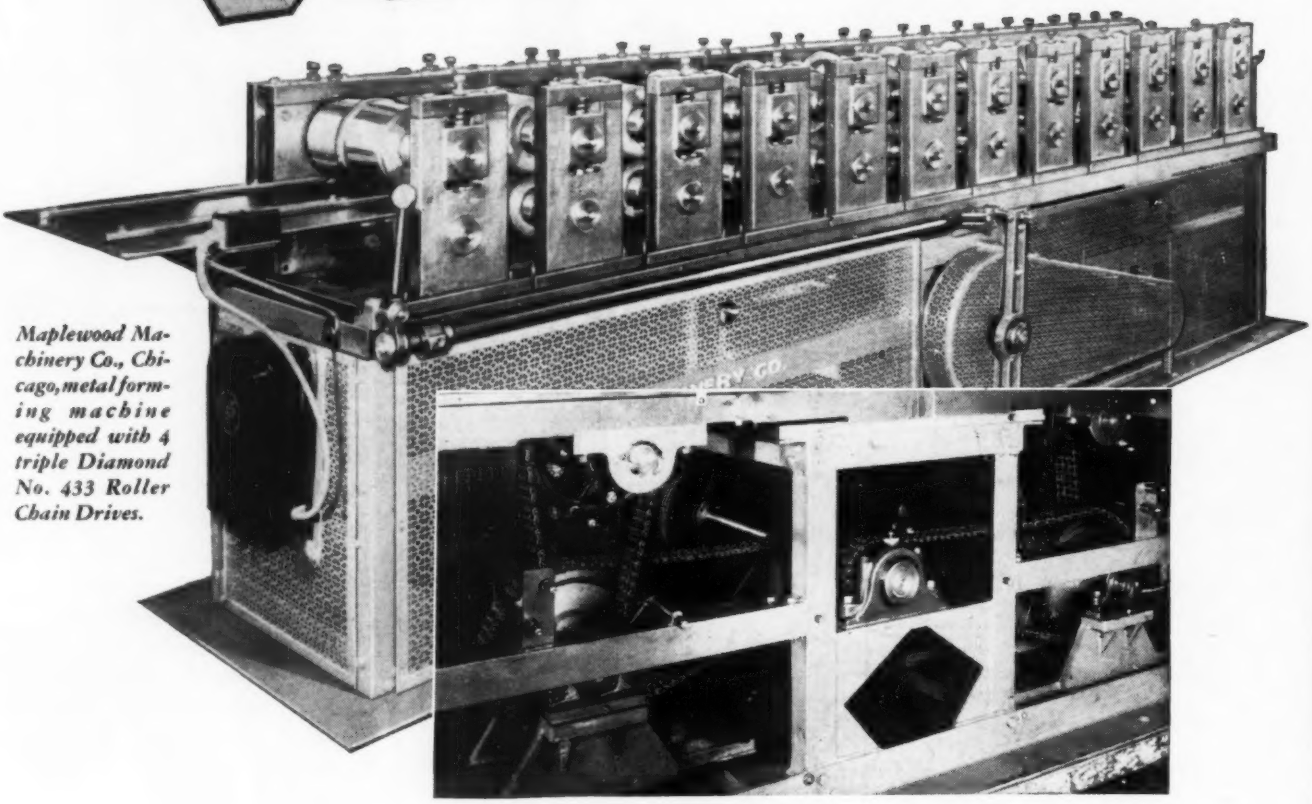
Diamond Roller Chains Speed Metal Fabrication



Maplewood Machinery Co., Chicago, metal forming machine equipped with 4 triple Diamond No. 433 Roller Chain Drives.

● Operating the forming rolls on the high speed Maplewood metal fabricating machines, Diamond Roller Chains provide the non-slipping positive drives required for maximum output.

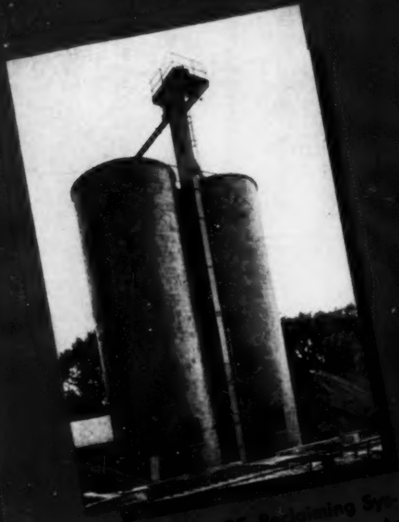
Savings made are further insured by the long-life dependability and the reserve strength of Diamond Chains.

To be sure of maximum output of machinery you build or use, you can rely on Diamond Roller Chains . . . Assistance or suggestions on appropriate drives are yours for the asking. DIAMOND CHAIN COMPANY, Inc., Dept. 413, 402 Kentucky Avenue, Indianapolis 7, Indiana.

Offices and Distributors in All Principal Cities.

Write for Big Drive Catalog 649

DIAMOND ROLLER CHAINS



TILE SILO STORAGE: Reclaiming System Uses Entire Capacity of Silo As Live Storage.

CONCRETE SILO STORAGE with Live Storage Shelf Feeder — Elevator — Weigh Larry.

CYLINDRICAL STEEL TANK STORAGE: Feeder and Elevator Direct to Stoker Hopper.

SUSPENDED STEEL BUNKER STORAGE: Feeder — Elevator — Weigh Larry Direct To Stoker Hopper.

your COAL STORAGE PROBLEM

Fits Into ONE of These Pictures...

Wherever you are located, whatever space you have available, however much capacity you need . . . one of these four basic types of G-W Coal Storage Systems should fit your requirements.

The difference between a good and a poor coal handling system is in the *application* of proved engineering principles acquired through experience plus common sense and the integrity of the manufacturer. Gifford-Wood has designed each of the four types shown on the basis of a definite application for geographical location, available space and initial cost per ton of available storage.

G-W *knows* how to meet such conditions, and applies 140 years' of experience to the design of coal handling and storage systems for steam generating plants. Then the *one* right system is fabricated and installed under *one* contract, *one* delivery schedule and *one* responsibility.

Gifford-Wood's engineering service is available to consultants, engineers and plant owners at no obligation. Get in touch with a G-W engineer today.

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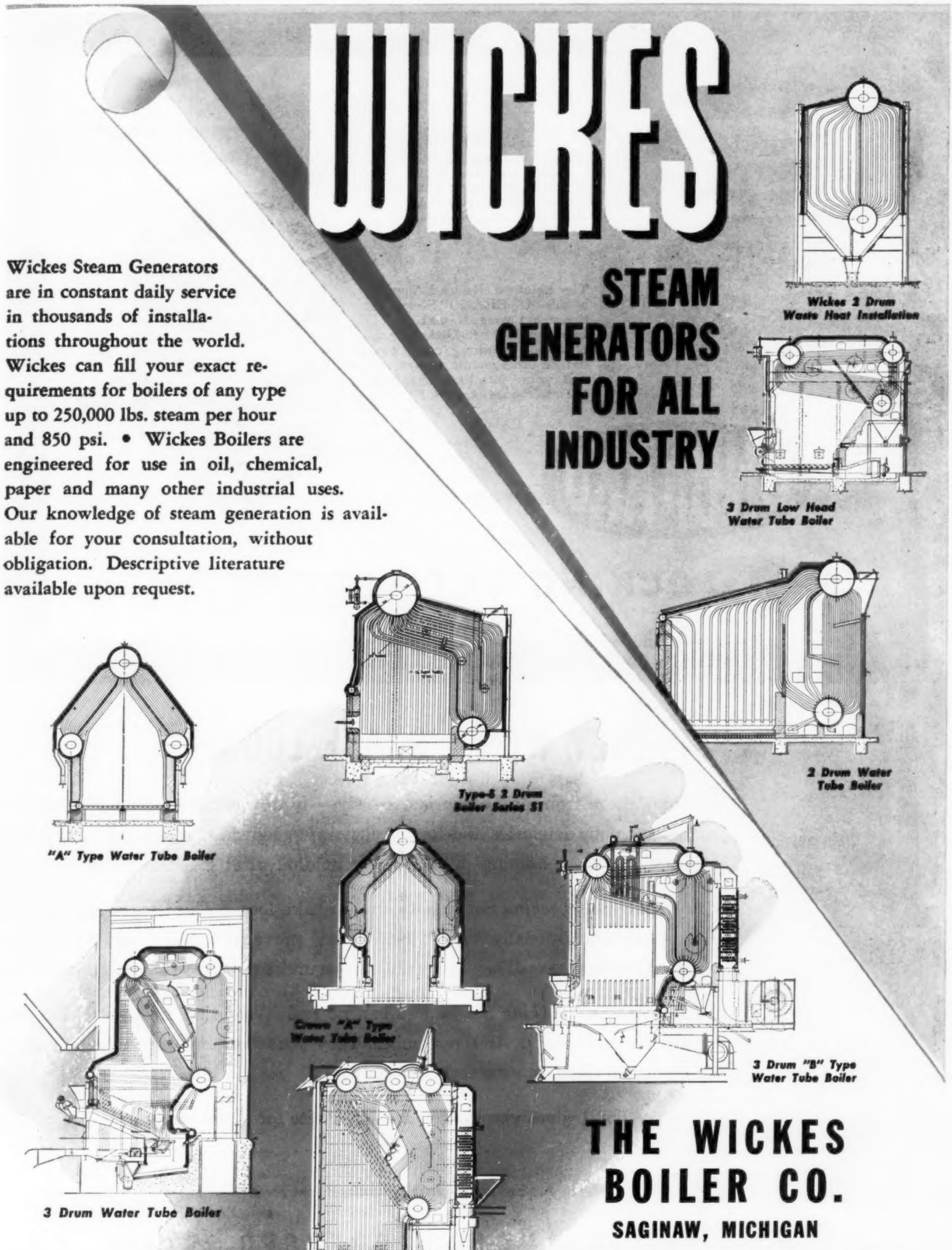
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Wickes Steam Generators are in constant daily service in thousands of installations throughout the world. Wickes can fill your exact requirements for boilers of any type up to 250,000 lbs. steam per hour and 850 psi. • Wickes Boilers are engineered for use in oil, chemical, paper and many other industrial uses. Our knowledge of steam generation is available for your consultation, without obligation. Descriptive literature available upon request.
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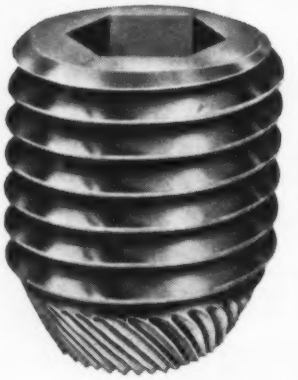

The patented Knurled Cup Point of this popular "UNBRAKO" Socket Set Screw makes it a Self-Locker, because the edges of the counter-clockwise knurls positively prevent creep, regardless of the most chattering vibration. *"It won't shake loose!"*
Pat. & Pats. Pend.

The patented Knurled Threads of this "UNBRAKO" Socket Set Screw are swaged—making it a most excellent Self-Locker for applications requiring cone, oval, flat or other points except cup, and for use with hardened shafts. *"It won't shake loose!"**

UNBRAKO

SELF-LOCKING SET SCREWS

"...THEY WON'T SHAKE LOOSE"

Machine failure from any cause is expensive—in downtime, repair costs, lowered production, poor deliveries and loss of customer goodwill. Frequently such failure is caused by the loosening of set screws holding vital machine parts together.

UNBRAKO *Self-Locking* Set Screws won't shake loose! Their exclusive *knurling* makes them exceptionally vibration-resistant, prevents "creep" and subsequent loosening of the screws. They "stay put", even under the most chattering vibration.

UNBRAKO *Self-Locking* Set Screws can be real "Vibration Insurance" for *your* production machinery. And remember, they make an impressive selling point when you use them on your finished products.

Our folder 658-1 gives you further details. Write for yours today!

Knurling of Socket Screws originated with "Unbrako" in 1934.

*These screws are not carried in stock. Prices are available on application.

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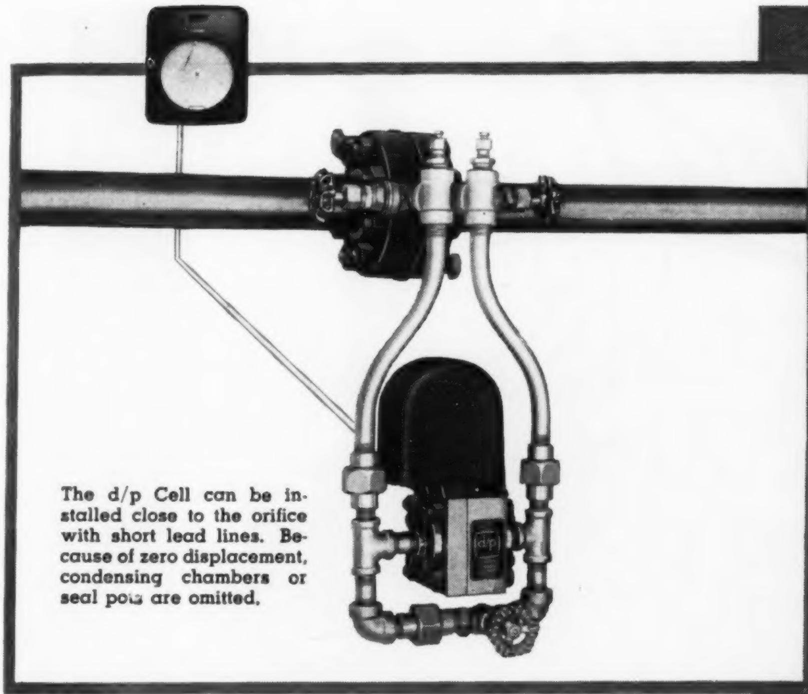
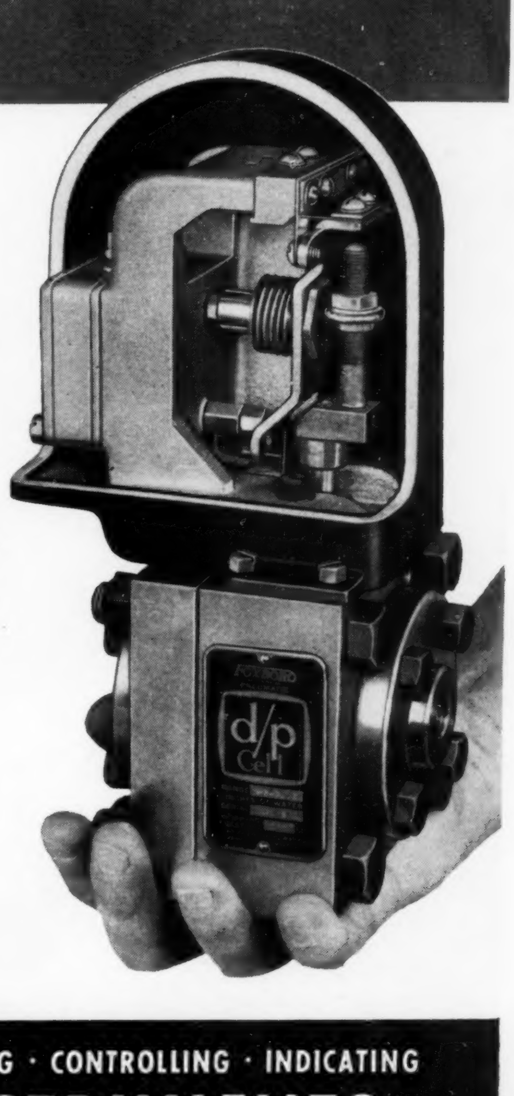


The d/p Cell can be installed close to the orifice with short lead lines. Because of zero displacement, condensing chambers or seal pots are omitted.

Simpler Flow Measurement

in the palm of your hand



NEW • REVOLUTIONARY • MERCURY-LESS

FOXBORO
DIFFERENTIAL PRESSURE CELL

Now you can simplify many troublesome flow problems . . . especially those where corrosion is a factor or the use of mercury is objectionable. This unique flow measuring device is accurate, easily calibrated, and widely applicable, and it weighs only 20 lbs. The Foxboro d/p Cell offers a combination of advantages that no other type of flow measurement can duplicate.

The Foxboro d/p Cell operates on the highly-accurate force-balance principle, transmitting flow measurement to remote, conveniently-located pneumatic receiving instruments (indicating, recording, controlling). Range: 100 in. to 800 in. Maximum working pressures: 500 psi and 1500 psi.

Get all the facts about this revolutionary new device for the measurement of liquid, steam, gas or air flow. Write for Bulletin 420. **The Foxboro Company, 182 Neponset Ave., Foxboro, Mass., U. S. A.**

UNIQUE ADVANTAGES

1. Type 316 Stainless Steel Construction.
2. Uses no mercury.
3. Essentially zero displacement—no need for condensing chambers on steam measurement or seal pots on liquid measurement.
4. Immediate, unfailing response to pressure changes.
5. Positive overrange protection.
6. Easy range change.
7. Simple field zero adjustment without disturbing force-balance mechanism.

FOXBORO
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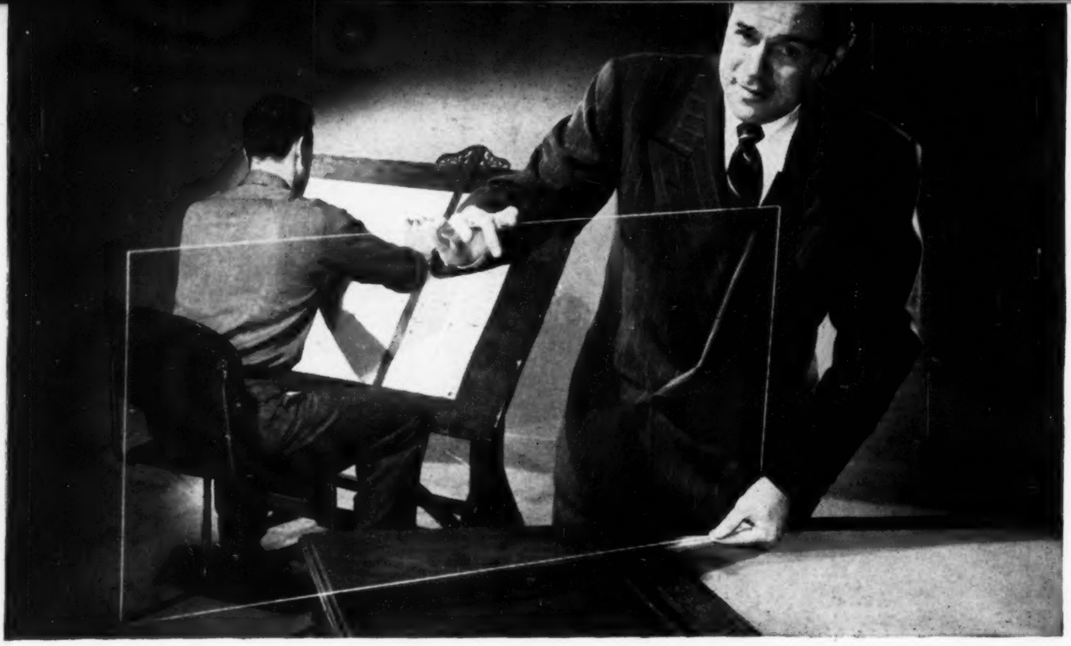
RECORDING · CONTROLLING · INDICATING
INSTRUMENTS


Doubled!
THE LARGEST SINGLE UNIT HOT PROCESS SOFTENER IN THE WORLD—AT WEIRTON STEEL
In 1926, Weirton Steel Co. installed the largest single unit hot process water softener in the world—a Cochrane 160,000 GPH unit—at their Weirton, W. Va., plant to treat 100% makeup for 225 lb., 525°F. boilers. So perfectly has this system operated that a duplicate was ordered for their new boiler plant, even though boiler pressures are now 850 lb. and the temperature 825°F. While capacity has been doubled, load can be swung from one unit to the other, if necessary. Installation has been completed, as shown by the above photograph, and is giving great satisfaction. A 600,000 lb/hr. Cochrane Deaerator has also been installed.
PIONEERS IN FEEDWATER CONDITIONING
COCHRANE CORPORATION · PHILADELPHIA, PA.
Write for complete details of this installation and a copy of Publication No. 3000
Cochrane
DEAERATORS · SOFTENERS · FILTERS · VALVES



* Here is an unretouched photograph of a ¼ in. thick, compression-molded plate fabricated by Plax Corporation from BAKELITE Styrene BMS4-A1. Note its unblemished, crystal-clear transparency.

You're Looking at the CLEAREST Styrene Plastic Available!

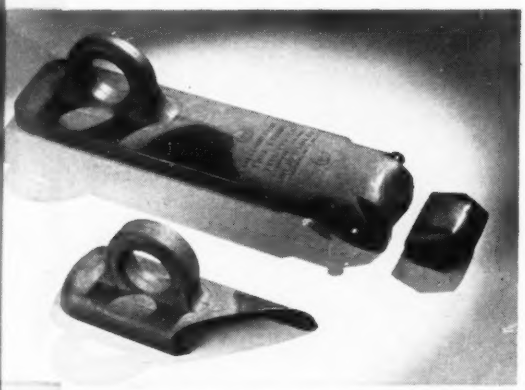
BAKELITE NEWS NO. 6

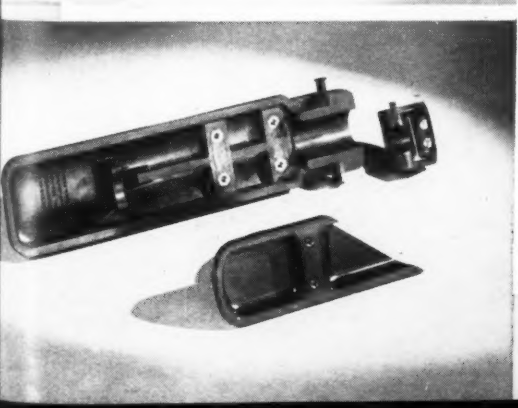
NOTES FROM BAKELITE CORPORATION ON BETTER, FASTER, LOWER COST PRODUCTION WITH "BAKELITE" PLASTICS

❶ You have much to gain by investigating *general-purpose* BAKELITE Styrene Plastics, which provide among the polystyrenes available today:

- **Greatest clarity and brilliance.**
- **Maximum cleanliness, at topmost requirement for whites, pastels, and colors.**
- **Ready availability as standard materials at standard low costs.**

These general-purpose Styrene Plastics come in two types. The *BMS4 group* offers the utmost in clarity, but needs higher heat applied to both material and mold to facilitate flow. The *BMS6 group* is specially processed to provide easier flow and excellent mold release at customary temperatures. Common to both groups are moldability to fine detail and lustrous finish, with strong acid- and alkali-resistance and excellent electrical insulating properties.

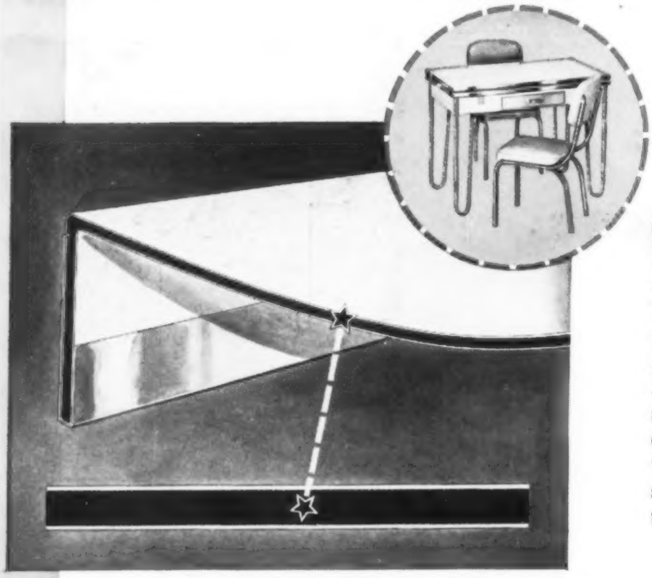




SIXTEEN YEAR Durability Test!

❷ The durability of BAKELITE Phenolic Molded Plastics has long been recognized as one of their chief attributes. Dramatic evidence of this durability was recently presented by the Line Material Company, manufacturers of fuse cutouts for power lines. These cutouts are fitted with doors or covers molded from BAKELITE Phenolic Plastics. The Line Material Company placed them on their roof test rack for exposure against the elements in highly corrosive atmosphere. The smaller cover illustrated has been exposed for 16½ years, the larger cover for more than 10 years. Both covers were sawed apart for examination of the interior construction. There was no deterioration. Although the surfaces had been dulled by the many years of weathering, the original lustrous finish was easily restored by buffing, as can be noted by the polished areas.

MORE BAKELITE NEWS ON NEXT PAGE

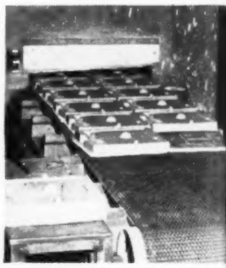


• Cutaway of a section of the 1/8" thick "Lloydite" table top, the heart of which is paper core stock impregnated with BAKELITE Phenolic Laminating Plastic.

It's What You Don't See That's ALL IMPORTANT!

❸ "Lloydite" table tops are plastic laminate all the way through, 1/8 in. thick, heat- and compression-molded in one operation, during which the "waterfall" edges and corners are formed and trimmed. They resist cigarette burns, alcohol, fruit acids, boiling water, and the many other hazards of the kitchen. BAKELITE Phenolic Laminating Varnishes are employed for impregnation of their core stock. Although unseen, the presence of these varnishes in the laminated structure is all important. They impart high tensile, flexural, and compressive strengths; low water absorption; corrosion resistance; wear and abrasion resistance, and lightness in weight. The ease and speed with which these phenolic varnishes are employed in treating the core stock makes for low cost production.

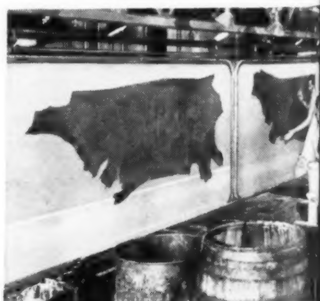
Is YOUR FOUNDRY Taking Advantage of RESIN Sand-Core BONDING?



Dielectric baking of re bonded cores for rail journal-box covers at rate of two a minute. Photo courtesy Induct Heating Corporation.

❹ Noteworthy advantages have already come from casting iron, steel, brass, bronze, aluminum, and magnesium . . . with the help of BAKELITE Phenolic and Urea liquid and powder resins as binders for the sand cores. Some of these advantages are: shorter core baking cycles than with non-resin binders, more uniform high quality of cores, improved collapsibility of cores, minimum moisture pickup permitting longer storage of sand cores to match the needs of production lines, and smoother surface finish that reduces the cost of cleaning castings. Sand cores made with these resins are suitable for either oven or high frequency dielectric baking.

A BIG Idea for Giant-Sized LAMINATES!



❺ These giant-sized pasting boards—used by the tanning industry—are "Consoweld" plastic laminated panels made with BAKELITE Phenolic Laminating Resins. They are produced in sizes up to 5 ft. 7 in. by 12 ft. 9 in. by 1/4 in.—even larger on special order—by Consolidated Water Power and Paper Company. Besides being lastingly smooth, the boards are light in weight and resistant to mechanical shock, chemicals, and moisture. They have excellent machineability, and stability through the temperature fluctuations of the tanning operation. Do they suggest a *big* application for you?

Bakelite

TRADE-MARK

PLASTICS

BAKELITE CORPORATION

BAKELITE CORPORATION
Unit of Union Carbide and Carbon Corporation UCC
30 East 42nd Street, New York 17, N.Y.

Design Changes Are Easy with Versatile, Adaptable Plastics!

Check coupon below for information on specific subjects illustrated. For general information, write for copy of Booklet G-8, "A Simplified Guide to BAKELITE and VINYLITE Plastics."

BAKELITE CORPORATION, Dept. A-18
30 East 42nd Street, New York 17, N. Y.

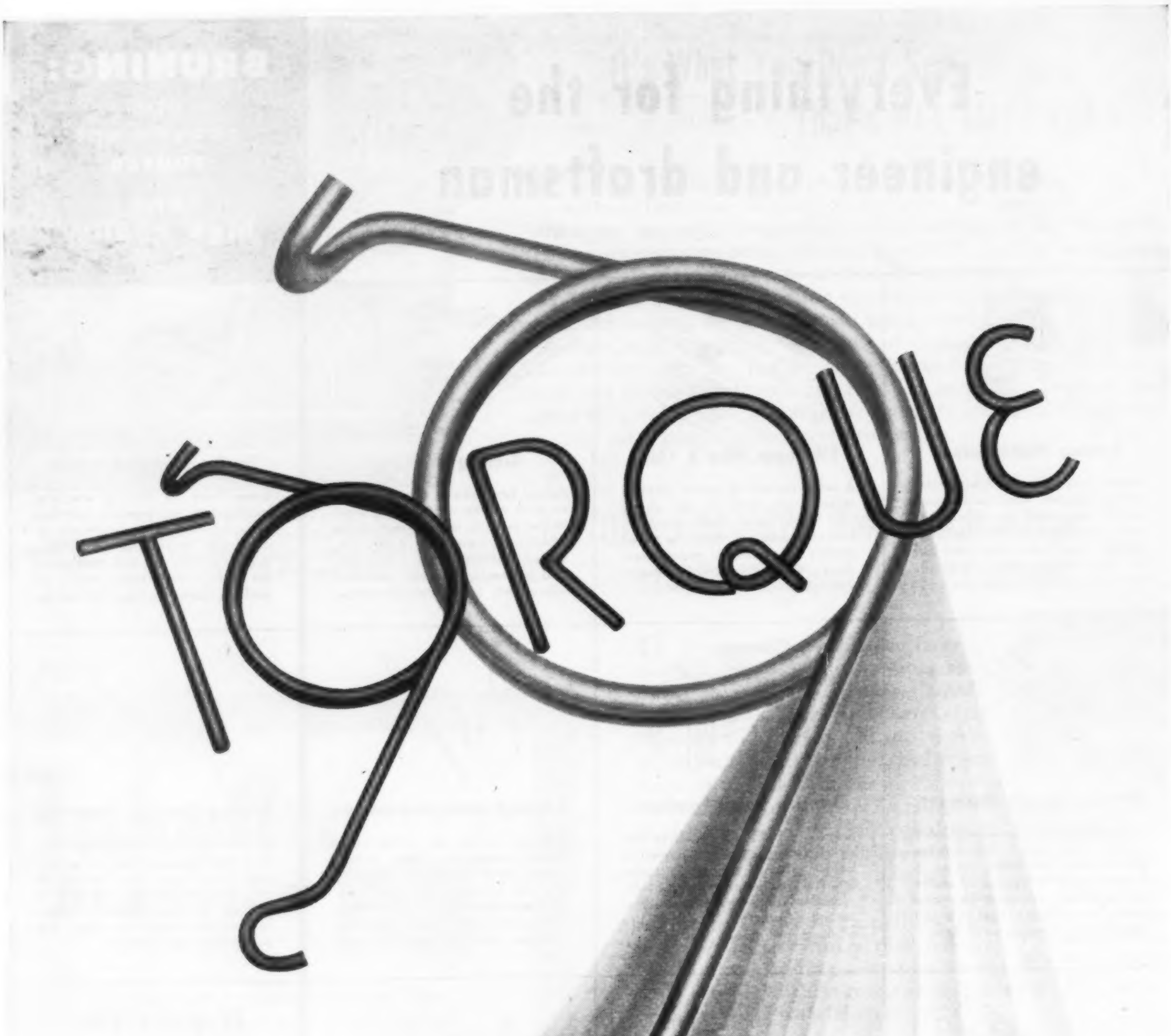
Please send information on subjects checked below:

☐ 1. BAKELITE Styrene Plastics
☐ 2. BAKELITE Phenolic Plastics
☐ 3. Phenolic Laminating Plastics for Table Tops
☐ 4. Resin Binders for Sand Cores
☐ 5. Phenolic Laminating Plastics for Large Panels

Your Name...Title.........................

Your Company...

Address.............................City.....................Zone......State.............


TORQUE

Only FORGINGS Offer So Many Sure Fire Ways to Obtain *Lower Costs* At The Point of *Assembly*

Macro-etch cross-section of Steering Lever forging shows how density of grain structure insures safety in operation of trucks and busses.

The maker of a Disc Clutch embodying this forged steel actuating lever increased the rate of machining two and one half times by having it forged.

A weight reduction of 22 per cent and a considerable saving in machining and finishing time was obtained by forging this Clutch Yoke used with an air-cooled gasoline engine.

This Sprocket forging weighs 18 lbs. less than the bar stock formerly required to produce it. Maker reports 40 per cent saving in machining and finishing time as result of forging to shape.

There are thousands of instances where forgings have reduced the cost of parts at the point of assembly. Forgings provide qualities and economies that are otherwise unobtainable. Forgings provide rapid assembly of complex parts by welding adaptability of widest range. Forgings permit reduction of dead weight because maximum strength and toughness are obtainable in lighter sectional thicknesses. Forging to shape avoids waste of metal and reduces machining and finishing time-cost. Forgings provide the strength and toughness for unrelenting and uninterrupted performance. The metal quality and cost-reducing possibilities obtainable in forgings cannot be duplicated. Recheck every stressed part in your equipment, as well as simple handles and levers, and consult a Forging Engineer about the possibilities for reducing parts' costs at the point of assembly. Only a Forging Engineer can inform you fully regarding the numerous advantages obtainable with forgings.

ROP FORGING ASSOCIATION

A REFERENCE BOOK ON **FORGINGS** FOR ALL USERS OF METAL PARTS

DROP FORGING *Topics* ISSUED 6 TIMES A YEAR

DROP FORGING ASSOCIATION
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☐ Booklet on "Metal Quality—How Hot Working Improves Propertie of Metals"

☐ "Drop Forging Topics" which presents numerous end use application of forgings.

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Westinghouse

—and NOW...

Needs No Lubrication

Now . . . for the first time . . . you can install electric motors, or motor-driven machines . . . and forget motor lubrication.

Westinghouse Life-Line . . . industry's amazing, new, all-steel motor . . . now completely eliminates need for lubrication. Life-Line motors are equipped with sealed bearings, pre-lubricated with a more-than-ample supply of specially treated lubricant. Correct lubrication is assured . . . machine outages are reduced . . . motor-drive problems are simplified, since motors can be located without need for constant accessibility.

Added to Life-Line's plate-steel protection, improved windings and more compact size, *pre-lubrication* is one more important reason for starting to convert, today, to Life-Line power. Standard ratings available from stock—others on short delivery. Ask your Westinghouse representative for prices and delivery on your requirements, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

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Westinghouse Life-Line Motors

Service Champ AT YOUR SERVICE

MORSE-ROCKFORD
OVER-CENTER
FRICTION CLUTCH

FOR A REAL package of power transmission, here's a small-diameter clutch that offers dependable, powerful, trouble-free operation! It's the Morse-Rockford toggle-type over-center Clutch. The same over-center principle used in high torque, heavy duty tractor and hoisting clutches is found in this compact clutch design.

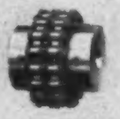
The Morse-Rockford Clutch's strong, symmetrical body and release sleeve are accurately machined to provide top performance and efficiency. Its operating links, pins, and collars are of hardened steel. The release bearing (shifter collar) is made of the highest quality bronze for long wear and high strength.

The toggle action of the Morse-Rockford Clutch goes "over-center," locking the clutch in driving position, and provides smooth, easy engagement for powerful pull. The toggles are factory-assembled with the release mechanism and adjusting plate as a unit, assuring easy assembly and disassembly. Adjustment is accomplished by loosening a conveniently located Locking Screw and turning the threaded, forged-steel Adjusting Plate by hand.

Four clutch models, each in three sizes, afford a great variety of arrangements with different driving cups. Morse engineers will make special application recommendations upon receipt of complete information. Catalog SDOC available on request. Write Dept. 371, the Morse Chain Company, Detroit 8, Michigan.

If design space limitations are your problem, check the Morse-Rockford Pullmore Clutch, a multiple-disc clutch transmitting heavy loads in comparison to the clutch diameter. Write for the Morse Pullmore Clutch catalog.

Morflex Couplings



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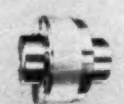

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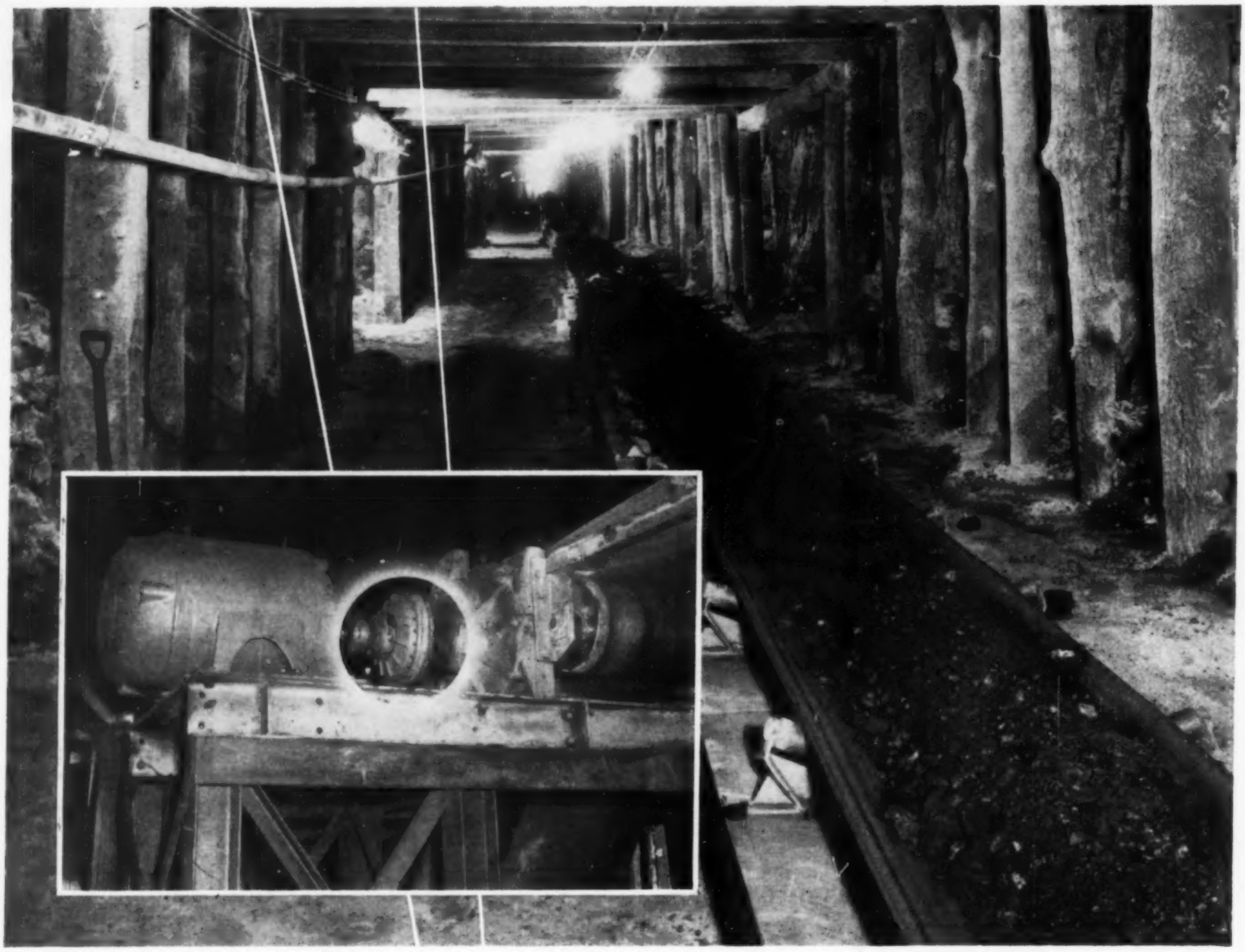

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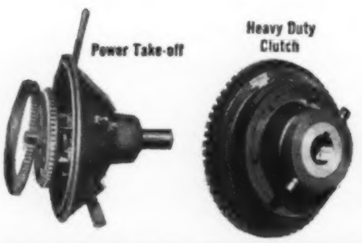

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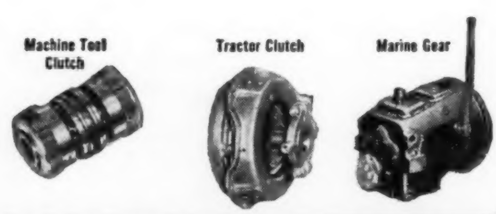

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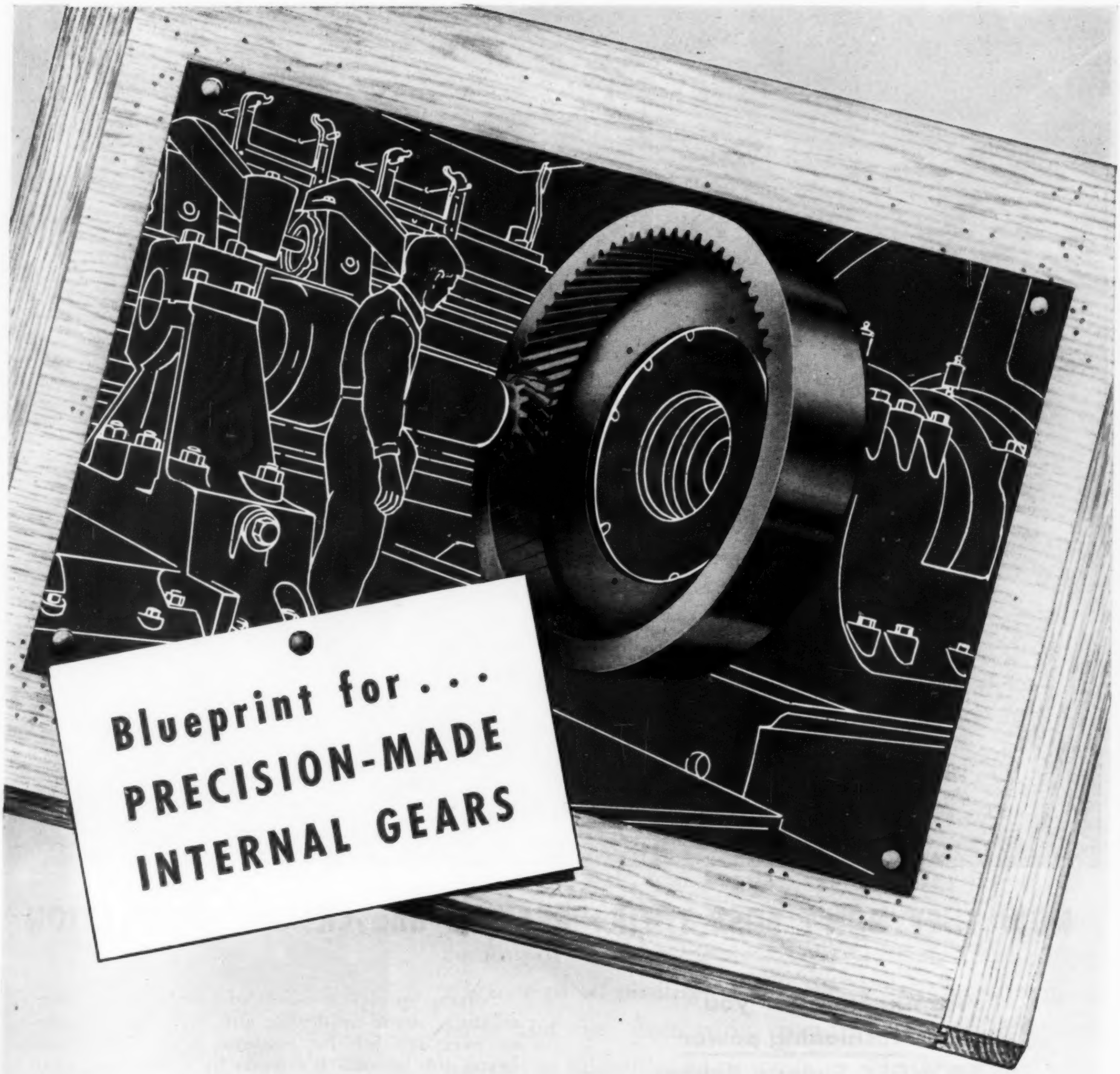

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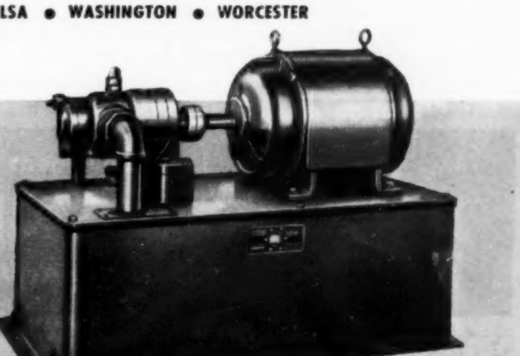

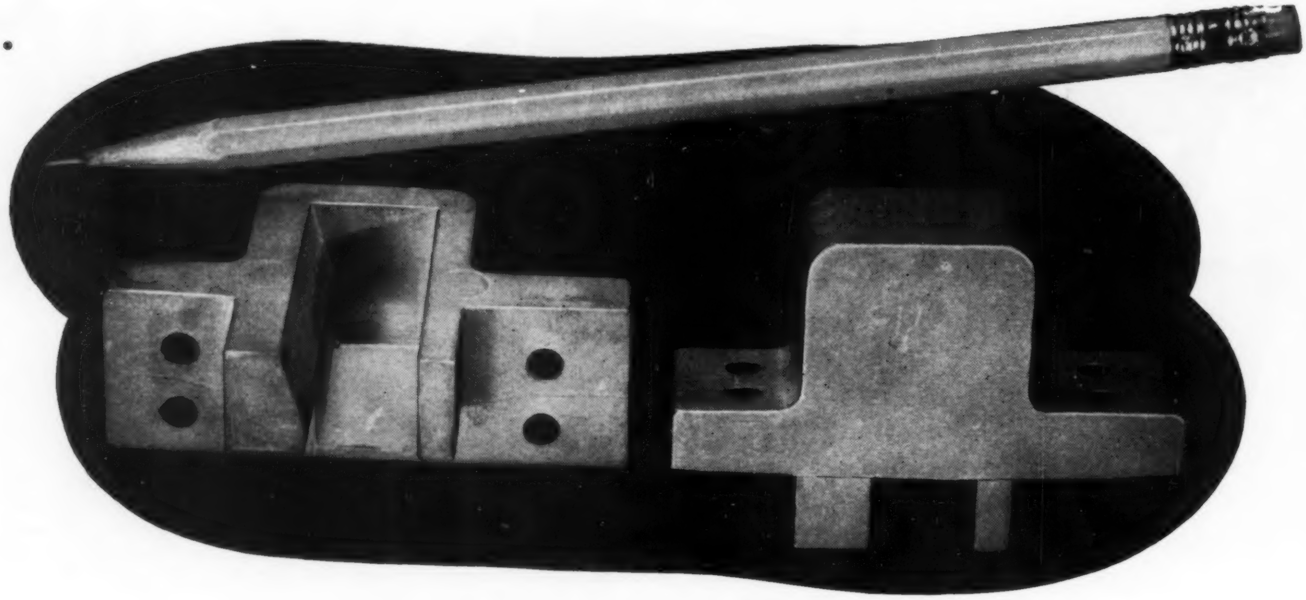

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Argon-Arc Welding of Thick Aluminum Plates

(Research on the welding of thick aluminum plates is being conducted at Battelle Memorial Institute, Columbus, Ohio. A survey report on this general subject was presented at the 1948 ASME Petroleum Division Conference, an abstract of which appears on page 501 of this issue.)

Volume 71
No. 6

MECHANICAL ENGINEERING

June
1949

GEORGE A. STETSON, *Editor*

Cradle of American Know-How

IT is pleasant to cast one's mind back over the last century and a quarter and contemplate the energy and enthusiasm with which the citizens of Philadelphia organized and conducted The Franklin Institute of the State of Pennsylvania for the Promotion of the Mechanic Arts, the purpose of which was defined in the constitution of that famous institution as: ". . . . the promotion and encouragement of Manufacture and the Mechanic and Useful Arts, by the establishment of Popular Lectures on the Sciences connected with them; by the formation of a Cabinet of Models and Minerals and a Library; by offering Premiums on all objects deemed worthy of encouragement; by examining all new Inventions submitted to them, and by such other means as they may judge expedient."

Surely no organization could have been devised that was better suited by its scope and purpose to perpetuate the genius of the distinguished American whose name it bore, to reflect the variety of his interests and of his coterie, which ranged from philosopher and savant to artisan, and to serve an infant nation whose destiny it was to provide an exceptional environment for the development of an industrial economy.

In the Commemorative issue, April, 1949, of the *Journal of The Franklin Institute* is reprinted in facsimile the first annual report of the Institute. It is an historic and revealing document, containing as it does the list of officers and standing committees for 1825; the Act of Incorporation; the Constitution adopted Feb. 5, 1824; the By-Laws; a list of members; four quarterly reports of the Board of Managers; the report of the Exhibition of 1824; and proposals for the Exhibition of 1825, addressed to the "manufacturers and mechanics of the United States."

Some idea of the variety of interests of the more than 600 persons who were members of the Institute during its first year can be obtained by glancing over the list which begins with John Agnew, fire-engine maker, and ends with Titus Yerkes, inn-keeper, and includes artisans of all kinds, professional men, merchants, bankers, manufacturers, and public officials. On facing pages of the list picked at random we find the following occupations: Postmaster, cordwainer, japanner, artist, skin-dresser, jeweller, agriculturist, Captain U. S. Navy, hatter, engraver, bookseller, carpenter, shuttle maker, plumber, machinist, currier, pattern and model maker, nail manufacturer, upholsterer, brass founder, professor of materia medica, refiner at the Mint, chairmaker, merchant, teacher, cotton manufacturer, gold-leaf manufacturer, turner, watch maker, counsellor, lamp manufacturer, chemist, U. S. marshall, smith, conveyancer, druggist, fire hose maker, book binder, distiller, powder manufacturer, wood corder, and tailor.

This varied group of Philadelphians represented the American know-how of 1825. Its members lived in the bright dawn of the machine age. Their ancient handicrafts were slowly being transferred to machines. The cottage system was beginning to give way to mass-production manufacture; and the relationship of the apprentice to the master craftsman was being transformed into the relation between labor and management. Machines and technology were of prime interest to them; new products, new industries, greater production to make America self-sufficient; to produce better goods than could be imported; to satisfy growing markets in a new world.

The report on the Committee on Premiums and Exhibitions shows how their thoughts were running: Blister steel, bar iron, japanned goods, broadcloths, satinettes, cabinet-ware, straw and grass bonnets, a machine for cutting and piercing iron plates, domestic carpetings, a maroon work box, a bassoon, a marble mantelpiece, a coal grate, spectacle glasses, a pianoforte, a copper roller for printing calico, cut glass ware, a bust of General La Fayette, screws "made at one operation by a machine of American invention from iron of their own manufacture," a clock. At the exhibition of 1824 there were exhibited articles of iron and steel, of copper and brass, chemicals, lead pipe, a rifle, a canal boat, two air pumps, surgical instruments, a seal press, a steamboat, a machine for pressing leghorn and straw hats, an alarm to attach to a watch, a tilt hammer, a sloop of war, a turning lathe, weavers' reeds, scale beams, portable earthern furnaces, fire brick, cotton and linen goods ("worked bureau covering, by a lad 9 years old, Thomas Hansel. Reflects much credit on the maker for his taste and industry"), woolen goods, leather, cabinet ware ("a tub made by a boy 10 years old, promises much for the young mechanic"), straw bonnets, specimens of the arts, paints, fancy articles ("three bread baskets, by a little girl eight years old, very creditable"), stationary [sic], musical instruments, agricultural instruments, thermometers, and "specimen of graduation, 1000 to an inch."

What a varied line of American manufactures this list presents! But more and improved products were desired, and the "Proposals for the Exhibition of 1825" offered medals for some 83 articles, only a few of which can be mentioned: A ten-pound specimen of the best cast steel, "best specimen of cast iron pipes . . . . . of one inch caliber, in sections of at least four feet long"; some 20 medals

for textiles; leather goods; pianos (upright and square); hats; reeled raw silk; paper; cutlery; grates; furnace "for consuming anthracite for generating steam"; best treatise on the construction of water wheels, on "causes of accidents in steam boilers and the means of avoiding them"; and on dyeing cloths; presses; writing paper; "most perfect stop cock"; the "best dissertation on the loss of power caused by the conversion of an alternate into a rotary motion, by means of the ordinary crank"; and dozens of other items.

Here, then, at Philadelphia was a cradle of American know-how, and only one, for at other places in the young Republic the same ferment of invention and development was in progress. A group of artisans, professional men, manufacturers, and merchants, with a zeal for enterprise and confidence in individual initiative, provided encouragement, incentive, and recognition for new and improved products, machines, and techniques, out of which emerged the great industrial economy in which we live today.

Expanding westward to the Pacific and southward to the Gulf, growing in size of unit, begetting a vigorous progeny, enriched by the discoveries of science, shaking off dependence on and the superiority of Old World products and methods, initiating, improving, originating, drawing an ever-larger proportion of the population into their orbits, creating cities, transportation and communication systems, markets, exchanges, jobs, and wealth, American industries changed the face of a continent and a way of life. And with them has grown into vigorous manhood that lusty child of New-World ideas, American know-how, that was cradled in Philadelphia more than a century ago.

Looking backward over this impressive record and contrasting 1824 with 1949, one wonders why it has become a popular sport to disparage these achievements, to enforce drastic changes in the system of enterprise under which American know-how developed, to lose faith in its future, and to substitute a fancied cradle-to-the-grave "security" for opportunity, incentive, initiative, and industry. Surely the problems that face us today, although different in character from those that confronted our forefathers, are relatively no greater nor more complex. Are the bright hopes of the first quarter of the nineteenth century to be darkened and obliterated in the closing half of the twentieth?

American Know-How Today

AMERICAN know-how must have more publicists like Pearl Franklin Clark, whose article appears on pages 465–468 of this issue, if it is to survive the creeping paralysis of doubt and misunderstanding which threatens it today. Wearied by two world wars and an economic depression, living under the shadow of fancied impending disaster, confused by social and economic changes, and weakened by a lack of faith in spiritual and moral values, we need such a statement of the philosophy, method, and achievements of American know-how as Mrs. Clark has given us. Its language is simple—devoid of technical jargon. It contrasts Old World and New World methods and thinking by means of case histories. It demands no background of engineering or industrial experience. Anyone who can read English can understand it. It is vibrant with sincerity and faith.

Some months ago attention was directed in these pages to Mrs. Clark's recent book, "Challenge of American Know-How." Book and article develop the same theme, the philosophy and method of American industrial management at its best. Mrs. Clark writes with the background of a woman who, for nearly two decades, watched her husband practice American know-how at home and abroad. "I am only a home-made, self-appointed specialist in the *spirit* that has gone into this know-how; into its principles and technics," she writes. "I am interested in this spirit because of its effect upon people. I make my tests like any housewife, in simple ways. I watch to see how people are affected by planning. Are they all included? Are they taking hold? Are they likely to? Do they understand it? Do they believe in it? Have they more hope than before? Is there a beginning of democratic results?"

Here, in simple language, are the criteria by which the know-how that attempts to administer the powerful forces at work in an industrial civilization must be judged. For if the know-how fails, the forces themselves may destroy us. What shall it profit us if the price of higher living standards is loss of human liberty and human dignity? Is it too much to hope that a way of life that has put science under the yoke, that has multiplied and glorified things, should generate within itself a means of multiplying and glorifying human welfare and moral values? Is it too fantastic to imagine that the engineers' know-how opens at least one avenue through which progress toward these goals may be made?

In the issue of the *Journal of The Franklin Institute* already referred to, Henry B. Allen quotes the following words of Joseph Priestley, written in 1780:

"The rapid progress true science now makes, occasions my regretting sometimes that I was born so soon. It is impossible to imagine the height to which may be carried, in a thousand years, the power of man over matter . . . . . O that moral science were in a fair way of improvement, that men would cease to be wolves to one another, and that human beings would at length learn what they now improperly call humanity."

Priestley wrote at the dawn of our present era, in a world torn by social, economic, and political revolution, not unlike the conditions that face us today. While he wrote, a new sense of human dignity, liberty, and equality was revitalizing the western world and creating an atmosphere in which his wildest dreams of a thousand years of scientific progress were substantiated within a couple of centuries. The dilemma that faced him still remains; but in the years that have passed there has developed a know-how that may yet help save the world from retrogression, if not destruction. It was born of necessity and opportunity and was nourished in the New World. It has adapted itself to technological change. It is today a factor in social and economic rehabilitation throughout the world.

Extending the American Know-How to Marshall Plan Countries

By MRS. WALLACE CLARK

WALLACE CLARK & COMPANY, NEW YORK, N. Y.

WHEN Mr. Turner telephoned and asked me to speak to you today, I thanked him for the compliment but said I could not do it. I had never made a speech in my life—the mere thought terrified me. He said, "You wrote the book,[1] didn't you?" I said, "Yes, but that was different. When you write a book you go into a room and shut the door and sit down at a desk—you don't face an audience." He said, "But they are all your friends . . . and it will be a small, informal gathering. . ."

I asked if I could call him back. He said I could. Then I started to think of reasons to tell him why I could not accept. But a curious thing happened. Although I continued to be terrified at the thought, I knew that I would come because there is something I have to say to the National Management Council that is bigger than my fear or my inexperience.

As most of you know, the Wallace Clark International Award has been established by the four leading engineering and management societies: The American Society of Mechanical Engineers, the American Management Association, the Society for the Advancement of Management, and the Association of Consulting Management Engineers. The award, a gold medal, is to be presented each year through this Council, to someone who may be from any country so long as he—or she—has made an outstanding contribution in the field of scientific management. What means even more to me, as I know it would to Wallace, is that with each yearly award going to the various individuals and countries in the coming years, there will always be a copy of my book which tells about Wallace's work and my part in it.

So these four societies and the National Management Council, all of which had so vital a place in Wallace's professional life and in his affections, have made it possible for us to go on traveling together to foreign countries in the future, making new friends, we hope, for all of these groups and for the American Know-How.

That is why I wanted to come here today to thank you and the others who are not present, for both of us, for this continuing privilege and happiness.

. . . .

The subject given me is: "Extending the American Know-How to Marshall Plan Countries." That seems a pretty big subject for a woman who knows as little as I do about economics, politics, and finance. But perhaps that is just as well. It makes me speak out of my own experience, from the bit of ground under my feet. No matter how tiny that bit may be, if you have worked for it and earned it, you have sent roots down that hold you, so long as you stand on it and are not tempted off base, onto ground that is not your own.

My bit of grass-roots experience has covered nearly thirty years as Wallace's partner in our management consulting firm. Twelve of those years—up to the last war—were spent in Europe where he and the staff were installing American management methods in industries of twelve countries, usually four or five countries at a time.

I am not an engineer and have never had any part in the technical side of the work. When I was not traveling with Wallace, I was looking after things for him in the office—taking part in staff conferences, reading the staff reports, editing and proofreading staff papers to be presented at meetings or to be published, and so on.

. . . .

Before we speak of extending this know-how to other countries, let us see what it is.

If published figures are correct, ECA plans to spend over four billion, that is four thousand million dollars, for aid to Europe during the fiscal year of 1949-1950. Of this amount, 15 million is to be spent on the export of American Know-How. That is less than four tenths of one per cent. What is this four tenths of one per cent?

Is it the technical know-how that is being sent with the machinery, equipment, processes, and even entire plants, through technicians and experts who go to install those things and teach people to use them?

Is it the management know-how that gives them the technics of production?

Is it the know-how we are supplying in other fields—financial, diplomatic, agricultural, public health? Is it in foreign investments? Development of natural resources?

I know how important these are to increased production and a higher standard of living—and for defense; and how desperately people in other countries are in need of them.

But to me that is not *all* of our American Know-How. It leaves out the most vital part.

. . . .

I use the word American quite humbly, to define the know-how that has come from people of *all* countries working in America and putting into it a spirit that they had in common and that our country did not seek to prohibit or control, so that in time this know-how became practical, democratic, and universal.

. . . .

When we went to Europe, I did not know much about the methods. I was told that they were the most efficient, to get the quickest and best results; that they included benefits for people such as shorter hours, better working conditions, the highest wages and living standard ever known; also that they were responsible for the production and prosperity which at that time—1927—made America the wonder of the world.

Still, I felt pretty gloomy about it. I could remember the panic of the 1890's and what happened to my family and friends

[1] "Challenge of the American Know-How," by Pearl Franklin Clark, Harper & Brothers, New York, N. Y., 1949.

Presented at the Annual Meeting. New York, N. Y., April 7, 1949, of the National Management Council.

as a result. I also knew what happened to people during World War I and after; and I kept asking myself, What was the use of better methods to get work done if panics and wars could come along and wipe out not only the work and factories, but people themselves?

Why hadn't men used the intelligence they had shown in other fields to wipe out panics and wars like other pestilences and plagues?

In Poland I began to realize that a beginning had been made. It had been going on quietly in American industry for some time. No one had been paying much attention to it because it looked like something else. It looked like a new way of cutting metals; or a new philosophy of industrial leadership; it looked like the "one best way of work"—in the phrase coined by the Gilbreths; it looked like methods to get work done; or removing all obstacles to a free flow of work; or increasing production, decreasing costs, improving quality, and other technical things . . . And it did all of these.

But there was something else.

There was a new way of thinking that had gone into the new methods. It was an *opposite* way.

For example, Polish directors and executives expected you to sit down with them in their offices in Warsaw while they told you what was wrong with their mills or mines or factories off in the provinces, then you would advise them what to do to get American results and they would press buttons and have it done.

They were surprised at a way of planning that went in "from the bottom up," to find out the facts on which action should be taken. They were used to getting their "facts" from plant managers who brought them to Warsaw. They could not approve a method of going in to listen to people down in the shop, to find what they thought their troubles were and what special skills or experience or ideas they had to help solve them. In their aristocratic tradition, such a procedure would cause a man to lose face.

The Americans I knew didn't seem to have any face to lose. They had university and engineering degrees and they were gentlemen, but they could be buddies with a greaser or oiler or floor cleaner or mule tender or any one at all.

People couldn't seem to get so low down in the scale that they were not included and regarded as individuals who were part of the work and important to it.

There didn't seem to be any corner or condition, any machinery or equipment that was too lowly to engage interest. Washrooms and lockers, light, air, temperature, water, even the broom and mop were all respected as part of a free flow of work.

This grass-roots approach revealed facts as far from those in Warsaw as were the executives themselves.

One example was used as illustration by a Polish engineer of our staff who spoke to a group of factory executives at the Institute of Scientific Management in Warsaw. He was telling his audience about the pumps.

In a pulp mill where he was working with Wallace, he explained how the Gantt planning chart had shown up a bottleneck. They went to see what was the trouble. There they found the huge digesters being filled by hand. Men would shovel in the wooden chips, then go in to tramp on them. . . This took time and held up the rest of the plant.

So the executives were asked to install a hopper with a spreader which would feed in the chips automatically, without interruption.

The plant manager, called to Warsaw and told to install such a hopper, replied flatly, "Niewozliwy!" (meaning impossible!) Such a hopper, he said, could not be run by their single pump. Told to install another pump, he said, "Niewozliwy!" That would overload the electric generators. "Buy another generator," the executives were advised. "To get a free flow of work, we must consider nothing static and nothing impossible."

When they went to plan for a new generator, they found there were *two* pumps, one of them being held for repairs, and both pumps were driven by *steam, not electricity!*

The Polish engineer told his audience that this was no reflection on the manager. It was a reflection on blind acceptance of an old way of doing things. "In America," he said, "a manager has often worked his way up, so that it is more usual for him to know what the facts are. Over here we are more apt to bring in someone who is highly qualified by education but who gets his information from someone beneath him and so down the line.

"In that way a director in Warsaw may be told by a plant manager in the provinces who has been told by a superintendent who has been told by a foreman who has been told by a skilled worker who has been told by an unskilled worker that something is "impossible," until this becomes accepted and believed and defended by men of intelligence. If they knew the facts they would end the "impossibility" at once.

"Obviously," he told them, "executives must get their facts from others, but there must be methods to make sure that the information on which they take action is correct."

Then he told about the gas masks. In another mill, the bottleneck was caused by men working in strong chemicals who had to stop at short intervals and go gasping for air. "They don't last long at this kind of thing," the manager said, "but there are plenty more where they come from."

Asked to supply gas masks, he shook his head. "I tried that. It wasn't any good. The men won't use them." Asked to show one of the masks, he had a hard time finding one and when he did, it proved to be an old clumsy type left over from the war, and defective.

A new, lighter type was accepted eagerly by the men and put into instant use.

. . . .

Some of you have read what I wrote about the Polish woodyard, off in the Provinces, where the executives in Warsaw thought they knew just what the trouble was. The men there, they said, were dangerous "bolsheviks" . . . You could deal with them only through labor contractors who were as hard-boiled as the workers. To prove how dangerous they were, they had just shot and killed one of the labor contractors.

The grass-roots approach was to go to the woodyard and study the flow of work. This located the trouble and the workers were found to be not dangerous bolsheviks but just men without enough work or wages or hope. When conditions were changed, there was no need to handle them through labor contractors.

One last example of this new way of thinking about people and their work, which impressed me so strongly during my first year in Poland, was in the spinning mills where a peasant girl was made supervisor.

There, the first bottleneck to show up on the planning chart was in the twisting department where a great deal of yarn was being spoiled. There, it was found, was no supervisor. The owner's son, in charge of personnel, said he would get one at once.

When it was suggested that he find someone right there in the department, he said that was impossible. ("Niewozliwy!") No one was qualified.

"Who is the best worker," he was asked. There was no doubt about that—any one could tell you—it was the girl over in that corner. But the advice to make her supervisor met with a horrified *Niewozliwy!* She was only a peasant . . .

How could she be supervisor? The others would not respect her or work under her. . .

But to improve quality in the American manner—and that was all that was discussed—the peasant girl became supervisor. Wallace said: "They won't have any more trouble there." And they didn't.

. . . .

As we went on with the work in Poland and other countries, I began gathering great hope for the future. Here were not only methods, I thought. Here was a way of planning that did not talk about democracy but—as it was used and to the extent it was used—put democracy into action.

The first principle of this new way seemed obvious: *Remove all obstacles to a free flow of work*. . . . You went in, not to dictate and impose but to observe and inquire . . . you only stopped listening when you were told that something was impossible or unchangeable. For here was another principle: *Consider nothing as static or unchangeable and nothing as impossible.*

To me that was exciting. When you saw how many static places and "impossibilities" were in people's minds, it was stirring news that here was a peaceful method to keep such thinking from interfering with a free flow of work which was for their own best interests.

Here was a way, not in argument, but in practical action, of "instructing those who oppose themselves."

In some of the old family industries, I saw a technic of agreement which disregarded differences—often violent and irreconcilable—and brought people together on one common likeness—their need for a free flow of work to achieve their own purposes. In this process, the experience of the older generation and of the past was not discarded, but was preserved and integrated with the energies and forward thinking of the younger.

And why, I began asking myself, if this democratic way of planning removes obstacles in a shop, a factory, a group of factories, or an entire industry in these different countries with their different conditions, people, and problems, why couldn't it do so on a still wider scale? Why couldn't it remove obstacles *outside* industries? Between countries? In the world? Why couldn't people come together on one or two points of agreement, in spite of their differences, for useful planning that would benefit all of them?

Of course, I was going on the assumption which was pretty general among Americans at that time, that our prosperity could never end. . .

But as I was looking ahead at the millenium, something happened. The Crash of '29. England off the Gold Standard. The Soviet Five-Year Plan . . . The limelight turned from America to Moscow, then as their Plan petered out, to Berlin . . . the rise of the Nazis and Fascists, totalitarian planning that was superplanning—with its inevitable result—World War II.

As we returned home, some of the factories with the new methods in which I had had such hope, were being bombed and destroyed, with the people in them.

I said in my book: "What I had been witnessing during these years in other countries was the contrast between two opposite ways of thinking about people. One, autocratic, totalitarian, from the top down, imposed its will upon people; used people, regardless of their rights, to build up power at the top and keep it there. Power was what mattered. Its methods were secrecy, fear, false promises, injustice. People's thinking must be dictated.

"The opposite way was democratic. It did not require any Ogpu or Gestapo. It controlled planning for people, not people for planning; freed people from old conditions that were holding them back; removed obstacles to their best accomplishment. What mattered, because this was practical, was the greater opportunity, security and *voluntary* co-operation of the individual.

"The first way, I told myself, was old-world—not because all in the old world used it or believed in it, but because there were its roots.

"The opposite way was new-world—not because everyone in the new world used it or believed in it, but because there it had been made practical.

"In the old way I could see no hope. It had been tried too often and found wanting. It always ended in wars, then re-juggling of powers and authorities, then the same misery and uncertainty for people.

"In the new-world way of helping people to help themselves, wherever they were, out of their own resources and patterns, was the answer for which men's minds and hearts had been searching always."

Back in America, after my foreign education—in factories—I was surprised to find how much old-world thinking remained in American minds, as obstacles to a free flow of work in our own country.

But there were *new-world* signs that were heartening. One was the Committee for Economic Development, headed by Paul Hoffman.

The idea in CED was to go into a community—but only if you were wanted—to help people study their own resources and plan their development; then to help them in their *voluntary* co-operation with other communities.

You didn't go in with lofty promises of bringing them freedom while you were riveting chains about their necks. You went in to put into their hands the know-how and to teach them to use it.

This was no visionary scheme. It was the thinking of practical men who got their economics out of the facts and knew that you could not have prosperity or stability in a country if it were not built up throughout the country; and that in a democracy it must be built by the people themselves.

The principle in CED is so vital, it should be carried on where all the world—including Americans—can study planning of, by, and for people.

In the Marshall Plan, there was this same principle—and there was Paul Hoffman.

There was an extension—on an international scale—of the same clear logic that there can be no stability in any country unless it is in all countries; and that the only security is for people everywhere to help build it.

Whether its short-range objective is to borrow time or to serve as a stop-gap, its long-range significance, like that of the CED, is in its principle—of helping people to help themselves.

Whether in this or that respect it bewilders us or disappoints us or irks us, whether we worry about the money and where it is coming from; or, as you often hear, What are WE getting out of it? Whether we find individuals or groups in the Marshall Plan countries who are critical and hostile and want none of our Plan, let us not play into the hands of our antagonist who speaks through them, and get out and let go of this principle, until we have convinced people of the world—including ourselves—of what it is and what it can mean for all of us in the future.

Some of us still have old-fashioned maps on our mental walls, where boundaries keep countries in, safe and separate.

Others have maps which show the continents as they appear from the North and South Poles, with flying distances in hours, to prove as no argument can, that it has become *One World*.

However, it is not on such maps that the decisive battles of the democracies and totalitarians will be fought. It is in people's minds.

Democracy's hope of survival—and I believe absolutely in its survival—is in getting people to choose it freely and not because they are afraid.

. . . .

We need to use our genius in packaging and advertising and marketing, first to analyze and to determine what it is we have to present; what, in practical terms, are its advantages; how does it work? How, not in words but in practice, does it differ from the product offered by our competitor?

Then we need to show it. We are good enough salesmen as a nation to know that we cannot sell something we do not show. We need working models—millions of them—that put our intangibles into tangible form as effectively as do our methods of management.

The people to whom we need to sell democracy are the hardest customers on earth. Fundamentally, they are people like ourselves, who want the same things we do. But their minds are tired. Their hearts are sick. They have had too many Trojan horses delivered within their gates. They have been lied to, dictated to, through the centuries. They have been promised bread and received a stone; reached out for freedom and found themselves in a booby trap.

They may be in the Urals, or Darkest Africa, or Tibet. Wherever they are, they are from Missouri and have to be convinced.

Even harder to sell are the young people. The democracies have not yet put anything in their showcase that appeals to the cynical, sharp-minded youngsters more than violence and escape.

. . . .

In totalitarian planning, they have technics to compel people to do and think and speak as they are told. Planning becomes effective at once.

Democratic planning takes longer. When you install new methods in a factory, there is often a long, heart-breaking period before people take hold and make the methods their own. And only then does the planning go into effect. But co-operation has been *voluntary*.

. . . .

Among the obstacles in peoples' minds to any progress in any country, are inertia, resistance to change and *fear*.

One of the old fears that has come out of the past with its poverty and famine, is fear that there is not enough; that you must build high walls with guarded gates and locked doors, about a country, province, or industry, if you would shut out want and keep abundance in.

Another fear is that if we teach *others* our know-how, so that they can produce the same things we do, only cheaper, what will become of our markets? And of us?

The classic reply was that of the Colonies who bitterly resisted becoming part of the United States. It was in the books that if you divided markets among thirteen, you would have only one thirteenth for yourself.

But the books were wrong. When the Colonies joined the Union, they became not one thirteenth, but thirteen times as strong—and stronger. Their freedoms were *strengthened;* their opportunities and prosperity *multiplied.*

The same thing happened later in industry. Some new-world minds who hadn't read the books or didn't believe them, who thought in terms of abundance, not lack, got the idea of scrapping some of the fine old inherited walls of thinking; and of pooling information, research, buying, and even markets.

The same old fears were there. Many began subtracting and dividing, to see how much they would lose. . . Again it was a problem in addition and multiplication.

Instead of losing, they found that markets and profits increased out of all proportion to what they could have dreamed. Some of them, undoubtedly, started building *new* walls to hold *that* abundance in. Some didn't see that a new-world miracle had been proved; or that a hint had been dropped that there *could* be abnndance if certain old ways of thinking did not interfere.

. . . .

Extending the American Know-How to Marshall Plan countries is a big, complex job with plenty of headaches and heartaches; plenty of old-world obstacles, many in ourselves, in our own minds; plenty of obstructions open and hidden, because our antagonist has to fight with all he has and cannot tolerate planning or methods to set people free. . .

In anything so vast and unprecedented, there are bound to be mistakes, contradictions or even, in some parts or details, what appear to be denials of its principles and of democracy itself.

But when people who have been engaged in it come back and tell about all the things that are wrong with it, we need to know and to remember what is *right* with it: the principle in it; the people who keep on with it because there is something in which they believe; the unflagging, unselfish services, the long, dangerous journeys and all of the personal sacrifices and hardships. . .

. . . .

I do not pretend to offer solutions to the many problems; or to tell how the American Know-How can be extended; or to say what new technics must be developed to make it more articulate, integrated, and powerful, to meet the totalitarian challenge. I leave that to the experts.

I am only a home-made, self-appointed specialist in the *spirit* that has gone into this know-how; into its principles and technics. I am interested in this spirit because of its effect upon people. I make my tests, like any housewife, in simple ways. . . I watch to see how people are affected by the planning. . . Are they all included? Are they taking hold? Are they likely to? Do they understand it? Do they believe in it? Have they more hope than before? Is there a beginning of democratic results?

I speak of this spirit at a technical meeting and before a technical group because I believe that this is the vital part of our American Know-How.

In this know-how there is increasing interest throughout the world. ECA is extending it. Leading societies such as the four I have mentioned are doing much to increase and share it; industries and universities are teaching it in its most practical form; others are participating; and now there is the National Management Council to co-ordinate and channel some of this interest and teaching and practical help through the International Committee in Geneva to Institutes of Management in other countries and so to the people in those countries.

We all remember in the last war how groups, factories, laboratories, all over the country were working on projects and products whose purpose they did not know until finally all came together in the atomic bomb.

In the same way, we have been testing out our know-how and its technics, working on bits and pieces that have seemed separate and unrelated, but which someday, somewhere, somehow, we fervently hoped would come together into a democratic structure.

But factories have taught us that isn't how it works.

If we don't want our bits and pieces fitted in for us by Master Planners to their Master Plans, we must take hold of our know-how—*with the spirit that is in it*—and use it.

In a Bold New Program, what could be bolder?

Packing GRANULAR MATERIALS

A Noiseless Method for Filling Packaging Containers

By WILLIAM E. GROSS

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IN filling gas-mask-canister sorbent containers, it is important that the density of packing of the gas sorbent be maintained consistently above a certain value. In addition, when filling axial-flow sorbent containers, the surface of the sorbent after filling must be perfectly level, otherwise the canister performance will be poor. The basic device[1] and the machines which are described and illustrated in this paper were designed in connection with development and study of gas-mask canisters in order to provide a means of filling the sorbent containers to a uniform and high density.

An accurate test method for determining the bulk density of granular materials and the volume of packed granular material in containers by means of volume meter E2R3 has been described previously (1, 2).[2] This method was used during the work described herein to determine the bulk density of the materials used for preparing premeasured charges of materials for filling into containers and for determining the degree of packing obtained in filled containers. The volume meter is essentially the same basically as the gravity packing device, except that the material being measured is filled into a graduated glass cylinder instead of a packaging container.

Prior to development of the gravity-type packing device and the gravity-type filling machines, canister sorbent containers were filled on commercial vibrating-type filling machines.

DESCRIPTION AND OPERATION OF GRAVITY-TYPE PACKING DEVICE

Only the basic gravity-type packing device (Figs. 1 and 2) is described herein. The machines illustrated in Figs. 3, 4, 5, have been described elsewhere (3, 4), although some details of their operation are given in the Appendix. The machines all employ the gravity-type packing principle for filling materials into containers. The machines were designed by the author.

The gravity-type packing device consists essentially of a frame on which is mounted a drop tube having a hopper mounted at the top. The hopper has a 0.437-in-diam orifice in the bottom. Three screens for scattering the granules are mounted in the upper end of the drop tube. The screens are spaced 1.5 in. apart with the uppermost screen located 1.5 in. below the orifice. A lower chuck for receiving the sorbent container is located below the drop tube on the frame of the device. An upper chuck for receiving the open end of the container is attached to the lower end of the drop tube. This chuck centers the sorbent-container inner tube and shapes (round) the open end of the container.

The gravity-type filling device is shown in Figs. 1 and 2. In Fig. 2 the following items are shown schematically:

1 Hopper for receiving the premeasured charge of material to be filled into the container.

2 Orifice for regulating the flow of material from hopper 1.

3 Dispersal screens for scattering the material and distributing it evenly over the cross-sectional area of the drop tube. The screens are made of 3-mesh hardware cloth. They are spaced 1.5 in. apart, with the uppermost screen located 1.5 in. below the orifice in the bottom of hopper 1.

4 Drop tube; the filling material falls freely from the bottom screen described in 3, a distance of 2 ft, into the container which is placed between chucks 5 and 6.

5 Upper container chuck, which automatically centers the inner tube of the container and shapes round the open end of the container.

6 Lower container chuck.

7 Brackets for supporting drop tube 4. The drop tube is free to be raised vertically so that a container may be inserted between chucks 5 and 6.

8 Frame.

In order to fill a container by means of the gravity-type packing device described herein, a premeasured sample is poured into the hopper at the top of the device and allowed to discharge through the orifice in the hopper, through the distributing screens, and through the drop tube into the container.

The premeasured samples are prepared by means of volume meter E2R3.

DISCUSSION

A dispersal head is employed to spread the falling granular material so that it falls evenly over the cross-sectional area of the drop tube. This insures level filling and uniform density. Another purpose of the dispersal head is to reduce the head required to secure maximum packing. Tests have shown that without use of the dispersal head 7 ft free fall of the granules was required to secure maximum packing. Evidently this distance was needed for the stream of granules leaving the orifice to expand gradually to a diameter equaling that of the drop tube.

Dispersal heads containing 1, 2, 3, and 4 screens were tested. Three screens were found sufficient to give maximum packing with minimum height of free fall. A number of different dispersal heads were tried during the course of experimental work on the gravity packing device. The screen type was found to be the simplest and most effective. However, with packing devices having dispersal heads of 1.5 in. ID and smaller, the screens were unsatisfactory in that they tended to become clogged. A cross formed by two 0.62-in-diam wires was tried as a dispersal head for small drop tubes but it was abandoned because it also tended to become clogged. A steel ball was found to be satisfactory for spreading the material in small-diameter dispersal heads (1.5 in. and smaller).

Experimental results showed that, using the gravity-type packing device with a material having a bulk density of 0.6 g per ml or greater, the density of packing increased with increase in height of free fall until a height of approximately 2 ft was reached.

[1] The basic packing device is fully protected by letters patent: "Volume Meter for Granular Materials," by J. C. Goshorn and W. E. Gross, U. S. Patent no. 2,332,512, Oct. 26, 1943. Patents are pending on the machines described in the Appendix.

[2] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Machine Design Division and presented at the Spring Meeting, New London, Conn., May 2–4, 1949, of The American Society of Mechanical Engineers.

FIG. 1 BASIC GRAVITY-TYPE PACKING DEVICE

The successful operation of the gravity-type packing device depends upon dropping the material that is being filled into the packaging container at a slow rate of flow through a dispersal head which scatters the granules so that they fall evenly over the cross-sectional area of the drop tube. In order to obtain maximum packing of materials, sufficient head, that is, height of free fall or the distance between the lowermost portion of the dispersal head and the top of the packaging container being filled, must be provided. When filling gas-mask-canister charcoal, which has a bulk density of 0.4 to 0.7 g per ml, as determined by volume meter E2R3, it was found that a head of approximately 2 ft is required. This same head was also found sufficient for maximum packing of lead shot having a diameter of 0.05 in. and a bulk density of 6.98 g per ml.

The gravity-type filling apparatus is based on the principle that the impact of the falling particles tends to impart a movement to the particles in the surface layer of the material being collected. This movement aids in orienting the granules so that they fit closely together into a minimum space. (A similar principle, in so far as orientation is concerned, is involved when packing materials into a minimum space in packaging containers by the conventional mechanical-vibration method which is widely used commercially.) The particles remain in motion after they fall into the container until they are approximately 0.1 in. below the surface of the material which is being packed and of which they form a part.

This can be demonstrated by preparing a mixture of black and white materials, such as charcoal and soda lime, and filling it into a glass container by means of the packing device. The materials can be observed moving about on and below the immediate surface of the mass as long as material is still falling.

It is assumed that the energy required to cause the granules to move about and orient themselves is acquired during their free fall in which it is considered that they achieve sufficient momentum to give maximum packing. Experience has shown that, with gas-mask charcoal having a bulk density of 0.4 to 0.7 g per ml increasing the height of free fall beyond 2 ft does not increase appreciably the density of packing. This height is also sufficient for maximum packing of very heavy materials such as lead spheres as mentioned previously.

In order to obtain maximum packing of the sample mass when using the gravity-packing principle, it is necessary to regulate the flow of material into the container. If the rate of feed is too fast, the movement of the surface granules is arrested by the weight of succeeding granules before they can complete their orientation. This prevents maximum packing. Experimental tests have shown that, within limits, the slower the granular materials are fed into the packaging container, the denser is the packing obtained. However, extreme slow feeds are disadvantageous in that the smaller orifices used to decrease speed of filling are apt to clog.

An orifice of 0.4375 in. diam was selected as standard for filling all gas-mask-canister sorbent as it gave reproducible and adequately dense packing and would pass continuously without clogging, at the rate of approximately 8.4 sec per 100 ml, the largest-mesh-size granular material (12–30 U. S. standard sieve scale) used in the U. S. military gas-mask canisters. Larger orifices may be used to increase the speed of filling, although some decrease in density of packing will result (3). However, when filling commercial packaging containers, which generally do not require maximum density of packing, it probably will be preferable to accept a slight decrease in density in order to achieve more rapid filling of the containers.

For example, with a decrease of about 1 per cent in efficiency

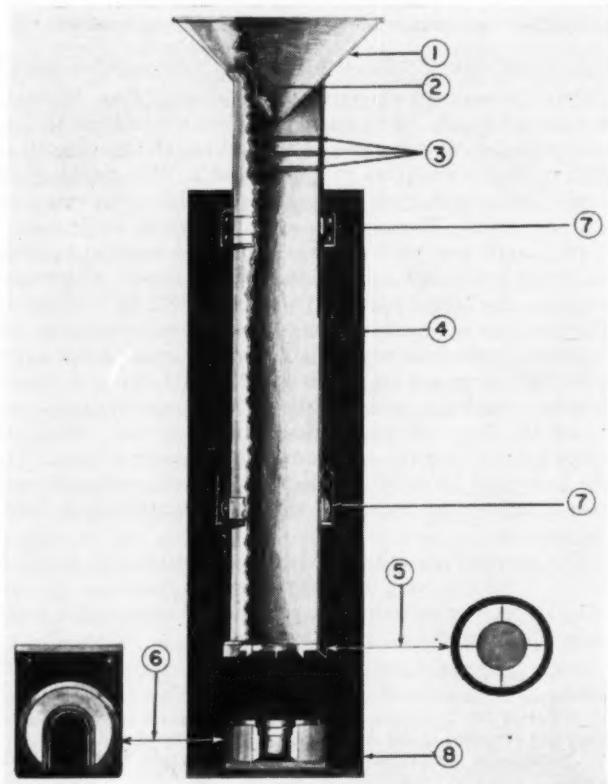

FIG. 2 SCHEMATIC DRAWING SHOWING CONSTRUCTION OF GRAVITY-TYPE PACKING DEVICE

of packing the gas-mask canister, sorbent containers can be filled at the rate of 3.3 sec per 100 ml. As stated previously, the material used for the work described herein was 12–30 mesh size; when packing materials of other mesh sizes, it will be necessary to proportion the orifice to give the rate of feed desired. The rate of feed is dependent upon the density of packing required.

It is believed that the method of obtaining packing of granular materials by dropping the granules from a height, at a slow rate of feed, has an effect similar to that obtained by tamping.

COMPARISON OF VARIOUS METHODS OF PACKING GRANULAR MATERIALS

Several simple methods of packing were compared with the gravity-type packing device during the development of volume meter E2R3 (1, 2). Packing the filling into containers by pouring through a funnel was tried but the results obtained were unsatisfactory in that the packing was the least dense of the various methods tried. Also the density of packing varied with the diameter of the funnel spout. Due to the slower filling, the packing becomes better as the diameter of the funnel spout is decreased. (This principle, whereby increased packing results from decreased filling speed, is used in construction of the gravity filling device described in this paper.) This method does not pack the material nearly as densely as is accomplished by either the conventional vibrating filling machines or the gravity-type canister-filling machines, and the material will settle still further if the container is subjected to vibrations similar to that encountered in handling and shipping.

Tapping the containers against a solid surface to pack the filling was also tried but was found unsatisfactory in that it required considerable time, was awkward in operation, and gave density of packing which may vary considerably with different operators.

Results obtained on the gravity-type packing device and the conventional vibrating-type filling machine are compared in Table 1. The results show that the packing obtained by the gravity filling device is of slightly higher and more uniform density.

TABLE 1 COMPARISON OF VOLUMES OBTAINED WITH GRAVITY-TYPE FILLING DEVICE AND CONVENTIONAL VIBRATING-TYPE FILLING MACHINE

No. of container	Volume obtained with gravity-type filling device, ml	Volume obtained with standard vibrating-type filling machine, ml
1	274	275
2	275	270
3	276	275
4	274	274
5	276	271
6	276	272
7	275	273
8	275	274
9	276	273
10	276	271
	275.3 avg	272.8 avg

NOTE: These tests were made with dry charcoal granules of 12–30 mesh (U. S. standard sieve scale) having a bulk density of 0.6 g per ml as determined by volume meter E2R3 (1, 2). The granules were filled into gas-mask-canister sorbent containers.

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3[3] "The Gravity Method of Filling Gas Mask Canisters and Other Containers With Granular Materials," by W. E. Gross, Technical Division Memorandum Report No. 1196, War Department, Chemical Corps Technical Command, Edgewood Arsenal, Md., 1946.

4[3] "Automatic Gravity Type Filling Machine E11 (for Radial Flow Canisters)," by W. E. Gross, Technical Division Memorandum Report no. 1355, Department of the Army, Chemical Corps Technical Command, Army Chemical Center, Md., 1948.

Appendix

ADDITIONAL TYPES OF GRAVITY FILLING MACHINES

The gravity-type filling machine E6 (for axial-flow sorbent containers) is shown in Fig. 3. This machine was designed to provide a single-tube machine for experimental filling of con-

[3] Obtainable from the Office of Technical Services, Department of Commerce, Washington 25, D. C. The Office of Technical Services designation numbers were not available for these reports at the time this paper was submitted for publication. However, the designations given in these references should be sufficient for their procurement.

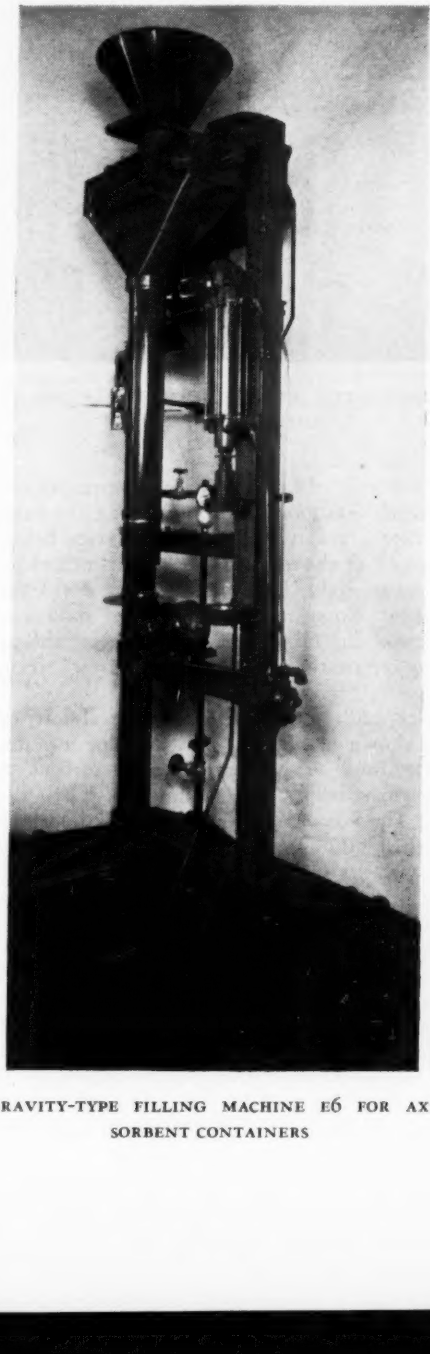


FIG. 3 GRAVITY-TYPE FILLING MACHINE E6 FOR AXIAL-FLOW SORBENT CONTAINERS

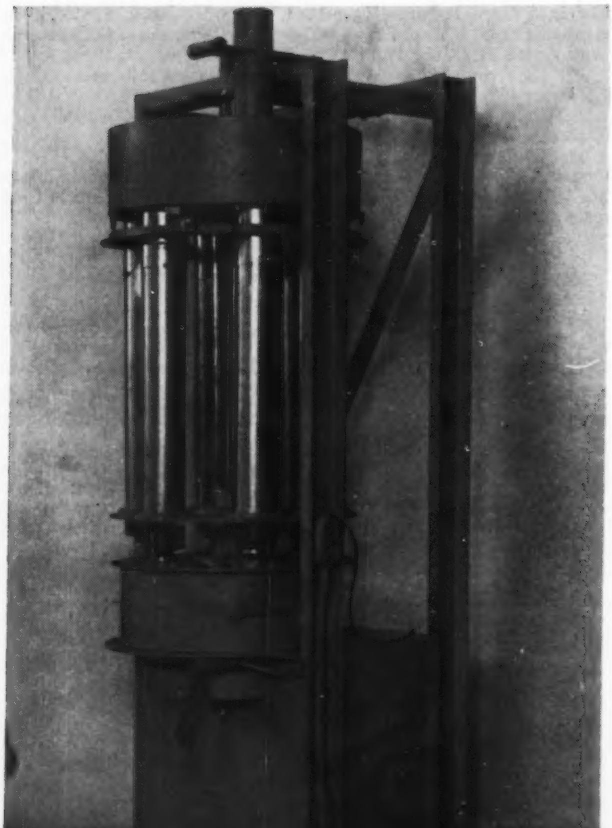


FIG. 4 GRAVITY-TYPE FILLING MACHINE E14 FOR AXIAL-FLOW SORBENT CONTAINERS

tainers. It consists of a commercial volumetric-type measuring machine which was modified by increasing the height of the frame, placing a gravity-type packing device below the discharge opening of the measuring mechanism, and providing a motor-driven turntable below the packing device for rotating the container. Rotation of the container insures a perfectly level surface of the filling in the container; this is required when filling certain types of gas-mask-canister sorbent containers.

Gravity-type filling machine E14 (for axial-flow sorbent containers) is shown in Fig. 4. This machine was designed for production filling of gas-mask-canister sorbent containers. It will fill a maximum of 960 containers (of 250 ml capacity) per hour. The maximum rate of filling is influenced proportionally when filling containers of different volumes. It is equipped with six filling stations and packing devices. The volume of filling delivered to the containers is controlled by cam-operated slide valves placed below the flow-regulating orifices in the packing devices. The quantity of sorbent delivered to the containers is varied by adjustment of the valve-closing cam. The flow-regulating orifices are located in the bottom of the large cylindrical hopper to which the tops of the packing devices are attached. Rotation of the sorbent containers during the filling operation is provided to insure that the surface of the filling will be perfectly level. Containers are shown in the filling position below the packing devices. The container shown at the front of the machine is in the loading-unloading position and has been lowered to facilitate its removal. The operation of the machine is automatic, except that the containers are loaded into and removed from it by hand.

Automatic gravity-type filling machine E11 (for radial-flow sorbent containers) is shown in Fig. 5. This machine was designed for large-scale production. It has a maximum capacity of 3600 containers (of 330 ml volume) per hour. The maximum rate of filling is changed proportionally when filling containers of larger or smaller volume. Thirty filling stations and packing devices are provided. The filling charge for each container is measured by a volumetric measuring apparatus, located at the right top of the machine, and delivered into the hoppers shown above the packing devices. The quantity of sorbent delivered to the containers is determined accurately by adjustment of the measuring apparatus. The empty containers are fed into and filled containers discharged from the machine automatically. The inclined gravity-feed conveyer at the right of the machine may be supplied either by a belt-type horizontal conveyer or by an extension of the inclined gravity-feed section. The discharge conveyer at the left of the machine is designed to place the containers directly onto a horizontal belt-type conveyer. No provision is made to rotate the containers while they are being filled as it is not required for radial-flow sorbent containers.

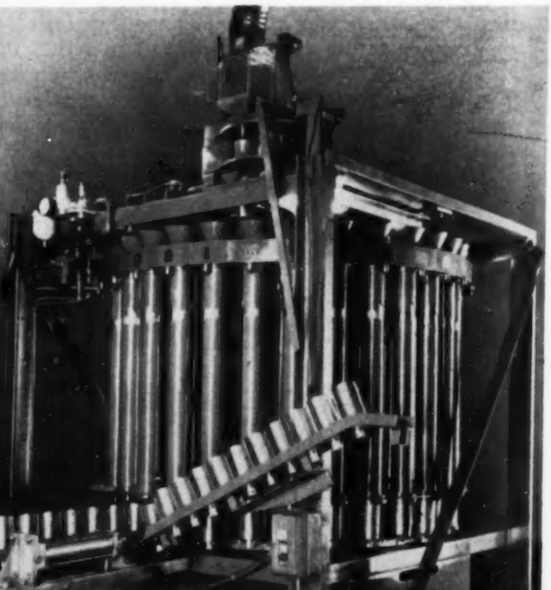


FIG. 5 AUTOMATIC GRAVITY-TYPE FILLING MACHINE E11 FOR RADIAL-FLOW SORBENT CONTAINERS

New Development in

ROTARY MULTIPORT VALVES[1]

By N. E. BRICE,[2] W. HORODECK,[3] and H. L. TIGER[4]

BASIC DESIGN AND OPERATING PRINCIPLES OF MULTIPORT VALVES PREVIOUSLY AVAILABLE

WHILE multiport valves of various types have long been used in various industries, it is not surprising that the use of such valves has been given great impetus by the water-conditioning industry and more particularly by the zeolite water softener (now included in the general category of ion-exchange units). The zeolite softener or ion-exchange unit embodies a number of steps in its operating cycle, i.e., normal service until its capacity is exhausted, followed by various reconditioning steps which comprise backwashing, regenerant introduction, rinsing, and return to service. Since the usual industrial installation is designed for one to four complete operating cycles daily, it is clear that the use of conventional individual valves requires many valve manipulations which can be reduced and simplified greatly by the use of a single multiport valve in place of the individual valves. This is clearly illustrated by the two diagrams shown in Fig. 1, with summaries of the respective valve operations for the required operating steps in the cycle.

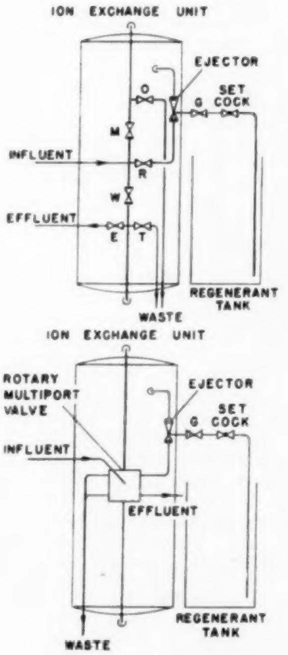
Thus an ion-exchange unit equipped with individual valves requires the attention of a careful operator for about 1 to 2 hr during the reconditioning steps, and the manipulation of the various separate valves involves some chance of error.

In order to take advantage of the simple and foolproof operation of single multiport valves, various types have been developed and installed during the past 15 or 20 years. The design and operating principles of the three main types hitherto used are summarized as follows:

Sliding Disk Rotary Multiport Valve. In this type, Fig. 2, the rotor is held tightly against the seating surface (port plate) in all positions and also while it is being rotated from one position to another by the combined action of spring pressure and water pressure. In each position communication is established between the appropriate inlet and outlet ports by means of the opening, the transfer cavity in the rotor, and the various openings in the port plate. Since the rotor must slide over the port plate, in passing from one position to another, it is necessary to use relatively hard materials such as hard rubber for the rotor facing and bronze for the port plate. To avoid leakage it is necessary to finish the rotor and port-plate seating surfaces with extreme accuracy. Thereafter, scoring of these surfaces by hard particles of grit or slight warpage of the castings may cause leakage requiring repair or replacement.

Furthermore, since the rotor must always be held firmly against the seating surface, substantial torque is required to rotate it from one position to another even with ample lubrication between the seating surfaces. This becomes especially apparent at higher pressures and on larger sizes, and it makes necessary the use of gear drives even on manually operated valves having $1^1/_2$-in. openings or larger. It follows also that there is an upper limit on size, the maximum hitherto being a size for 5-in. pipe connections.

Lift-Turn Rotary Multiport Valve. In this type, Fig. 3, the rotor is lifted manually from the seating surface by an external mechanical lever, rotated to the next position, and returned to the seating surface. This permits the use of a resilient rubber face against the metal seating surface which makes for tight



UNIT WITH INDIVIDUAL VALVES

Backwash. Open valves W and O. All other valves are closed.
Regenerant Introduction. Close valves W and O. Open valves R, G, T.
Regenerant Displacement. Close valve G.
Rinse. Close valve R. Open valve M.
Service. Close valve T. Open valve E.

UNIT WITH SINGLE ROTARY MULTIPORT VALVE

Backwash. Multiport valve in wash position. Valve G is closed.
Regenerant Introduction. Multiport valve in Regen position. Open valve G.
Regenerant Displacement. Close valve G.
Rinse. Multiport valve in rinse position.
Service. Multiport valve in service position.

FIG. 1 COMPARISON OF OPERATING CONTROL STEPS WITH INDIVIDUAL VALVES AND SINGLE ROTARY MULTIPORT VALVE

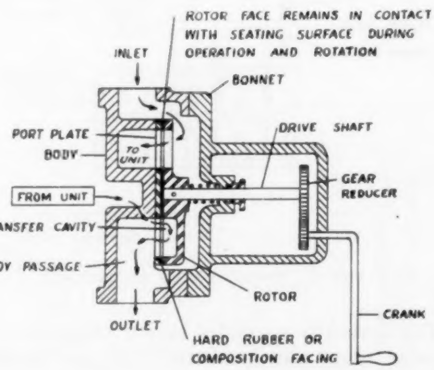


FIG. 2 SLIDING-DISK ROTARY MULTIPORT VALVE

[1] Patents applied for.
[2] Chief Engineer, Liquid Conditioning Corporation, Linden, N. J. Mem. ASME.
[3] Assistant Chief Engineer, Liquid Conditioning Corporation.
[4] Vice-President, Liquid Conditioning Corporation. Mem. ASME.
Contributed by the Process Industries Division and presented at the Spring Meeting, New London, Conn., May 2–4, 1949, of The American Society of Mechanical Engineers.

seating and resistance to leakage from scoring or warpage. However, the need for lifting the rotor mechanically, turning it, and reseating it, makes it impractical to motorize the operation of such a valve, because the operating mechanism would be quite complicated. Furthermore, the lifting of the rotor from the seating surface against pressure requires large operating force and this seriously limits the use of this type for larger sizes, the usual maximum being a valve size for 4-in. pipe connections.

Poppet-Valve Assemblage. This comprises a group of poppet

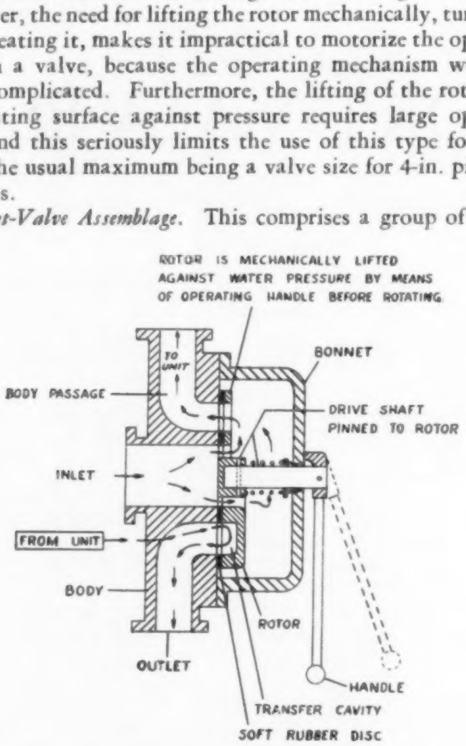


FIG. 3 LIFT-TURN ROTARY MULTIPORT VALVE

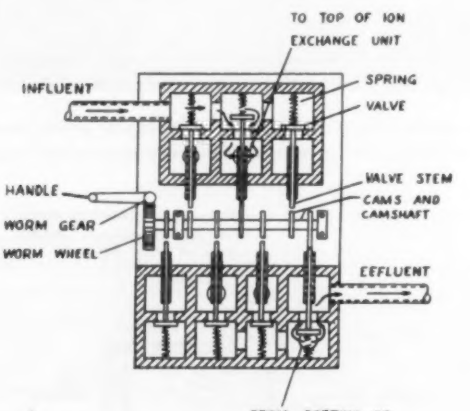


FIG. 4 POPPET-VALVE ASSEMBLAGE

valves, Fig. 4, usually assembled in one casing and actuated by a series of gears and cams to obtain the proper co-ordination of the various units in the assemblage for the successive operating steps in the cycle. This type is also limited by the large forces required to raise the disks from their respective seating surfaces. Furthermore, the many moving parts involved constitute a maintenance problem.

THE NEW VALVE PROVIDES GREAT ADVANCES IN OPERATION, IN FLEXIBILITY, AND IN PLANT LAYOUT

The new valve, Fig. 5, utilizes hydraulic pressure exerted on a diaphragm to set the rotor free so that it turns easily on a ball mounting. Thus the simple control of a small pilot stream of pressure water makes available instantaneously a large force which lifts the rotor swiftly and smoothly from its seating surface. In the manually operated design a slight thrust of the handle actuates the pilot valve which admits the pressure water to the diaphragm chamber to raise the rotor. As the rotor is raised the required distance from the seating surface (a fraction of an inch), it is kept in constant engagement with the driving shaft, which shaft is free to rotate but does not move axially inward or outward. The rotor is then turned to the next position and, as the handle is released, the fluid pressure is cut off automatically from the diaphragm chamber so that the rotor returns at a controlled rate to its seating surface in the new position.

The great magnitude of the rotor-lifting force becomes apparent by simple calculation. With a 10-in-diam diaphragm (about 80 sq in. of area), and a working pressure of 50 psi, the force available is $50 \times 80 = 4000$ lb or 2 tons. This force is substantially larger than the differential pressure which holds the rotor firmly against the seating surface in any given position. It is clear therefore that there is practically no upper limit on the sizes of valves which can be made and operated

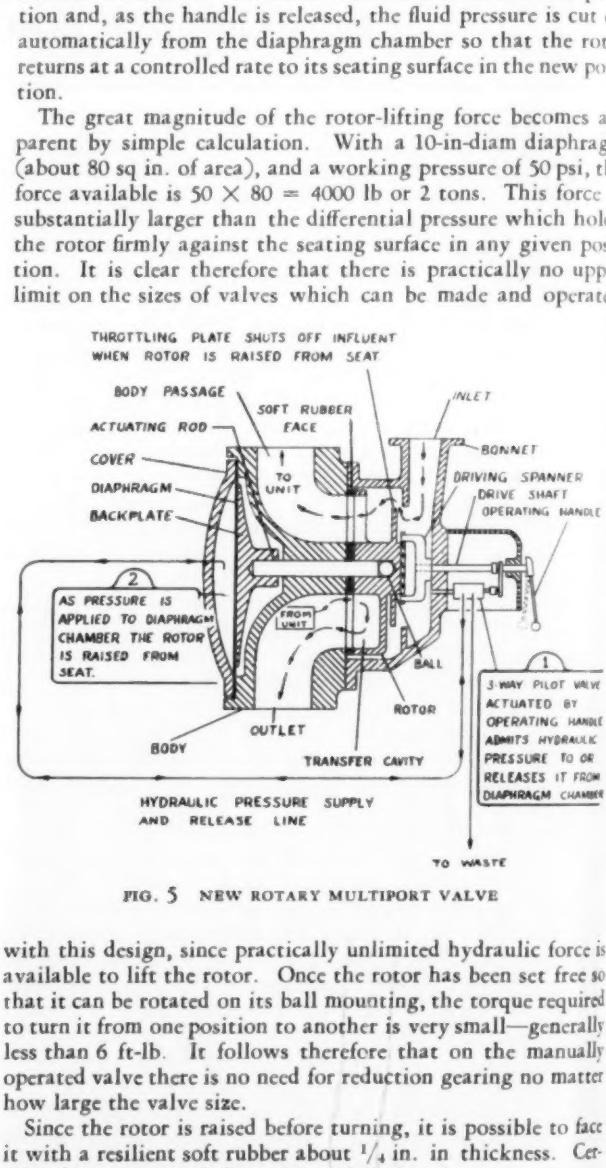


FIG. 5 NEW ROTARY MULTIPORT VALVE

with this design, since practically unlimited hydraulic force is available to lift the rotor. Once the rotor has been set free so that it can be rotated on its ball mounting, the torque required to turn it from one position to another is very small—generally less than 6 ft-lb. It follows therefore that on the manually operated valve there is no need for reduction gearing no matter how large the valve size.

Since the rotor is raised before turning, it is possible to face it with a resilient soft rubber about $^1/_4$ in. in thickness. Certain advantages result from this as follows:

1 When the rotor is pressed against the seating surface by the action of the spring plus differential water pressure, the rubber face is compressed by about one quarter of its thickness, i.e., about $^1/_{16}$ in. or 0.062 in. This compressibility is about 5 to 10 times as great as the deviation from flatness of the seating surface that can be expected from warpage of castings. Furthermore, this eliminates the need for great precision in finishing the seating surface. In fact, it makes possible the elimination of the port plate entirely and allows the face of the body casting itself to be machined. This face is then used as the metal seating surface. Obviously, such contact between the resilient, highly compressible rotor face and the metal seating surface

insures tight seating and eliminates leakage between ports or to waste.

2 Danger of leakage because of scoring is likewise eliminated. If a hard particle of grit lodges between the face of the rotor and the seat as the rotor is reseated, the particle merely deforms the resilient rubber temporarily. When the rotor is next lifted from its seat, there is a short period of flow of water over the face of the rotor to waste, dislodging the particle and washing it away without any injury to the face. It is well known that soft rubber is immune to being cut by hard particles, in fact, common experience shows that piping, chutes, and the like, lined with soft rubber, resist the abrasive effect of sand grains or similar particles much more effectively than does steel itself.

3 There is no need for lubricating the rotor face or the seating surface since there is no sliding action in the operation of the valve.

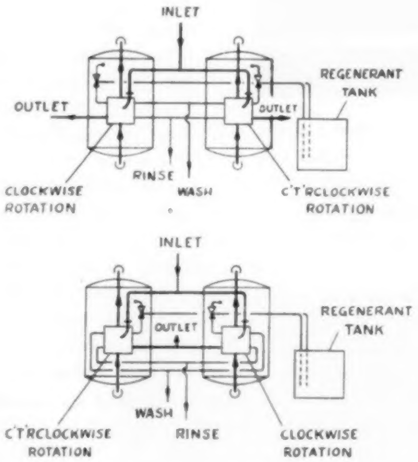


FIG. 6 TYPICAL LAYOUT FLEXIBILITY OBTAINED BY REVERSIBLE ROTATION OF VALVES

There are several other new features of design and construction in this valve which provide additional great advantages:

1 The inlet connection is brought into the bonnet. This permits locating the bonnet in any position around the circle which may be found convenient for the piping of a given installation.

2 Admission of the water to the bonnet plus the use of streamlined passages in the body casting result in a greatly reduced pressure loss through this valve; about one half the loss compared with other types of multiport valves having equal cross-sectional areas of the passages in the body. Thus where pressure loss is not a controlling factor, it is possible to use a valve of smaller dimensions, and where pressure loss is important, it can be reduced to a minimum by choosing the next larger-size valve.

3 The ports in the body casting are arranged symmetrically around the central axis. This permits the use of a right-hand or a left-hand rotor with corresponding clockwise or counterclockwise rotation. Such reversal of rotation reverses the functions of the side connections of the valve, making installation more adaptable to prevailing conditions, Fig. 6.

4 On 5-in. and larger sizes the bonnet is hinged to the body. Thus it is a simple matter to open the bonnet and expose the interior of the valve for inspection or service. This avoids the use of a block and fall or similar means which, in general, is required to handle the bonnet of this type of valve.

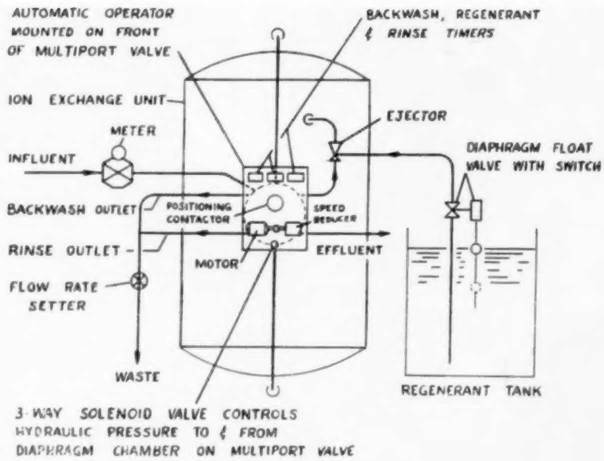


FIG. 7 DIAGRAM OF AUTOMATIC ARRANGEMENT

Operation

(*a*) *Initiation.* Automatic reconditioning cycle at end of operating run is initiated by push button, meter contactor, or time clock, so that solenoid valve and motor are energized and multiport valve is rotated to backwash position where it is stopped automatically in the correct location by the positioning contactor mounted on the valve drive shaft (this serves same function in each succeeding step).

(*b*) *Backwashing.* Water flows upward through unit and out to waste to cleanse bed. Duration of backwash period (usually about 10 min) is controlled by backwash timer. Upon completion, timer contacts close, causing multiport valve to rotate to next position.

(*c*) *Regenerant Introduction and Displacement.* Flow directed through ejector, causing regenerant to be drawn from regenerant tank and discharged into unit. When required volume has been withdrawn, the diaphragm float valve automatically closes ejector suction line and float switch starts regenerant displacement timer. Displacement water continues to flow through ejector and downwardly through unit to waste for required period when timer contacts close, causing multiport valve to rotate to next position.

(*d*) *Rinsing.* Water continues to pass downwardly through unit to waste at higher flow rate until waste products of regeneration have been completely rinsed out of the ion-exchange bed. Duration of this predetermined period is controlled by rinse timer. Upon completion, timer contacts close, causing multiport valve to return to original service position.

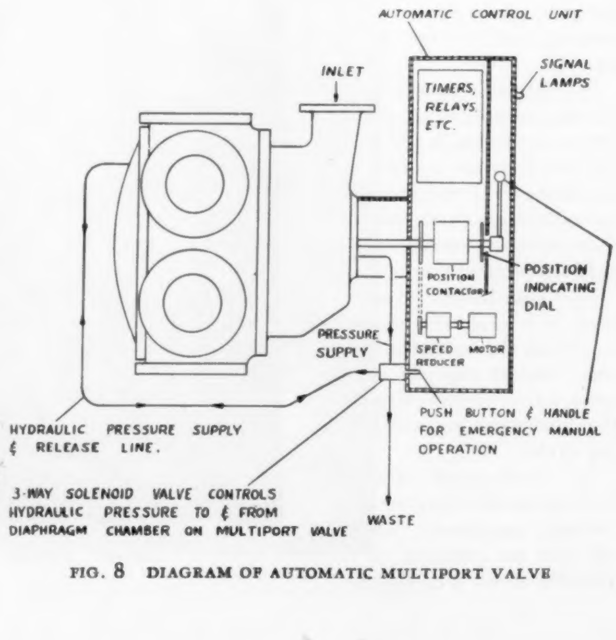


FIG. 8 DIAGRAM OF AUTOMATIC MULTIPORT VALVE

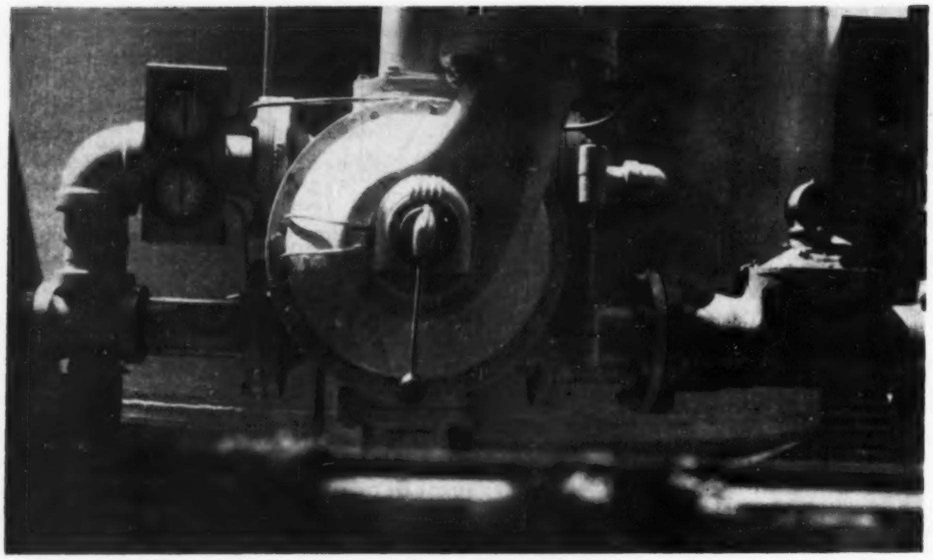


FIG. 9 FRONT VIEW OF DIAPHRAGM-OPERATED ROTARY MULTIPORT VALVE WITH MANUAL-OPERATING UNIT

ity meter to signal the end point of the run and initiate the automatic reconditioning cycle.

As previously stated, the reconditioning steps include backwashing, regenerant introduction, rinsing, and return to service. On industrial automatic units, the duration of backwashing is generally controlled by a time switch. The volume of regenerant discharged into the unit is usually controlled by a float switch which measures the required depth of liquid to be drawn from the regenerant tank. The duration of the rinse which follows is also controlled by a time switch. Fig. 7 illustrates diagrammatically the arrangement of an automatic unit.

NEW VALVE IS ESPECIALLY ADAPTED TO AUTOMATIC CONTROL

Various types of automatic operation and control of multiport valves have been developed in the water-conditioning field. Those more generally adopted use a motor with reducing gears and various cam arrangements to rotate the valve from one position to the next through the various steps in the operating and reconditioning cycle. Initiation of the series of reconditioning steps required at the end of the operating run is generally accomplished by one of the following methods:

(*a*) *Push Button.* When the end of the operating run is reached, an alarm or light signal is given by the meter, and the operator pushes a button which starts the reconditioning cycle, which then proceeds automatically through the various steps and back into service.

(*b*) *Meter.* After a predetermined volume of water has passed through the meter, an electrical contact is established. This starts the reconditioning cycle, which then proceeds automatically as in the foregoing.

(*c*) *Time Switch.* In some cases it is preferable to recondition the unit at a certain time of day. In such cases, a time switch initiates the automatic reconditioning cycle.

(*d*) *Conductivity Device.* With demineralizing or deionizing equipment, where all salts are removed, it is possible to use a conductiv-

As explained, in the case of this new multiport valve, the rotor is set free before it is turned from one position to the next so that a very small torque is required to operate this valve. Thus, in the case of an automatic unit, it is possible to use a fractional-horsepower motor (about $^1/_{10}$ hp) with the required speed reducer. This motor drive and speed reducer is the same for all sizes of multiport valves, and this makes it possible to standardize on one driving mechanism and to include it in a compact cabinet with all the other electrical control devices.

FIG. 10 ROTARY MULTIPORT VALVE WITH AUTOMATIC-CONTROL UNIT, WITH FRONT COVER OPEN

The arrangement is illustrated diagrammatically in Fig. 8. In this design, the pilot valve, which admits pressure water to the diaphragm chamber, is actuated by an electric solenoid instead of by the thrust of the handle as described for manual operation.

In addition to the space saving which results from the use of the small motor and speed reducer, these other important advantages are claimed:

1 The fractional-horsepower motor can be operated from the lighting circuit. Thus it is unnecessary to make any power-circuit connections as is the case with other types of automatic rotary valves which may require motors as large as 2 hp with correspondingly large reduction gears.

2 All of the control equipment, including the motor, is housed in a single, gasketed, waterproof enclosing case. This provides adequate protection for all types of locations including out of doors.

3 The automatic-control unit is provided with three time switches which permit independent adjustments to be made to backwash, regenerant displacement, and rinse periods. This feature permits maximum operating efficiency to be realized for each installation.

4 The uniform size and design of the automatic-control unit required for all sizes of valves makes it possible to use a uniform method of attaching the automatic-control unit to any size valve. This greatly simplifies the conversion of a manually operated unit into an automatic unit, because it is necessary simply to remove the manual-operating unit and replace it with the automatic-control unit. This can be done without shutting down the plant.

5 The small motor size and uniform design make it feasible to carry an ample stock of automatic-control units so that deliveries can be made rapidly.

6 Since the rotor is set free before turning, the small rotational force or torque required is practically independent of water pressure, spring pressure, degree of lubrication, or other factors. Thus the small torque required permits predetermined accurate positioning of the rotor, i.e., precise stopping of the rotor in each position, independently of any external conditions such as pressure.

Fig. 9 shows a 6-in. valve provided with a manual operating unit, and Fig. 10 is a similar valve provided with an automatic control unit. Fig. 11 shows an installation of four 10-ft-diam zeolite water softeners (each with 6-in. valve), operating in a nationally known bleachery. Many other units are in operation. In the course of their installation and field tests the reliable performance has been confirmed which was demonstrated by exhaustive long-term tests.

In addition to being adapted to a wide range of sizes, these valves can be made readily of corrosion-resistant construction. Furthermore, there is every indication that this type of valve with manual or automatic controls will be adaptable to a variety of applications other than water conditioning. It is hoped that experience will show that this new type of single multiport valve can usefully replace groups of individual valves in many other industrial fields.

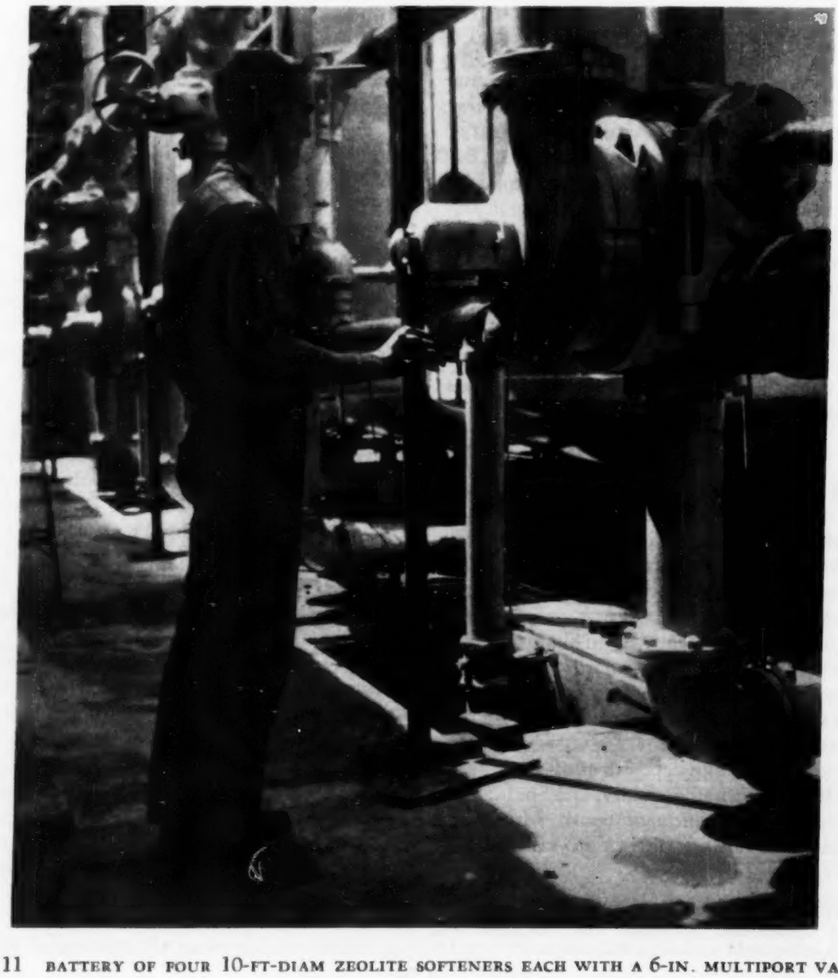


FIG. 11 BATTERY OF FOUR 10-FT-DIAM ZEOLITE SOFTENERS EACH WITH A 6-IN. MULTIPORT VALVE

MINING *of* COLORADO OIL SHALE

By TELL ERTL

MINING ENGINEER, UNION OIL COMPANY OF CALIFORNIA, RIFLE, COLO.

INTRODUCTION

The Union Oil Company of California owns in fee more than 20 square miles of land in northwestern Colorado that is underlain by oil shale. Most of this land was purchased in 1923–1925 to serve as a future resource of liquid fuel. During the past 23 years Union Oil scientists and engineers have been studying the problem of producing fuel and other useful products from this oil shale. Their research has resulted in developments which indicate that oil shale can be mined and retorted, and that shale oil can be treated to produce liquid fuels at costs not far greater than the present price of similar products refined from petroleum.

The commercial phases of oil-shale production, from mining until the product is ready for the customer, now are being studied thoroughly. Given time and the incentive to undertake the necessary construction work, the author's company feels that an abundance of synthetic liquid-fuel products from shale oil can be made available to the public.

OIL-SHALE DEPOSITS

Oil shale is a sedimentary rock containing organic matter insoluble in ordinary solvents but capable of yielding an oil on heating. Many oil shales are true shales since the inorganic matter is argillaceous; on the other hand, many oil shales, because the inorganic matter is calcareous or dolomitic, should be called marlstones, limestones, dolomites, or magnesian marlstones. The Green River oil shale of Colorado, Utah, and Wyoming is a magnesian marlstone.

Oil shale, besides not always being a shale, does not contain oil. It contains an organic solid known as kerogen, which probably consists of a mixture of compounds of carbon, hydrogen, oxygen, nitrogen, and sulphur. On heating oil shale to a temperature above 750 F, the kerogen is cracked into coke, gases condensable to an oil, and noncondensable gases.

OCCURRENCE OF OIL SHALE

Oil shale is found in most of the countries of the world, and in most of the states of the United States. It was formed in lakes or seas in which the deposit of inorganic matter was slow and in which abundant organic matter lived or was accumulated. The waters of the lakes were in a reducing condition so that the deposited organic matter was not oxidized. The organic matter of the better known oil-shale deposits consists chiefly of macerated and putrified microscopic vegetal organisms such as spore cases and algae. Larger vegetal matter, such as leaves and stems, and also animal matter, form part of the organic constituents of oil shales.

Foreign. The better known foreign deposits of oil shale are in Scotland, France, Sweden, Esthonia, Germany, and Spain; Russia and Manchuria; Australia, Union of South Africa, and Brazil. Oil-shale industries are operating in all of these countries with the exception of Brazil.

Contributed by the Petroleum Division and presented at the Petroleum Mechanical Engineering Conference, Amarillo, Tex., October 3–6, 1948, of The American Society of Mechanical Engineers.

United States. The most extensive oil-shale deposit in the United States is the black shale of the Chattanooga formation, which is richest in the states of Indiana, Kentucky, and Ohio, and is also found in fourteen surrounding states. The richest oil shale of the Chattanooga formation probably will not yield over 15 gal per ton from any large tonnage. Less extensive oil-shale deposits are found in Texas, California, Montana, and Idaho, and in many other states.

The richest oil-shale deposit and probably the one that first will receive commercial attention is found in the Green River formation of Colorado, Utah, and Wyoming. During Eocene time, 60,000,000 years ago, southwestern Wyoming, northwestern Colorado, and northeastern Utah had a warm, moist climate and contained large lakes. The Wyoming lake is known to geologists as Gosiute Lake and probably emptied into the Utah-Colorado lake, known as Uinta Lake. Uinta Lake often was two lakes, since during dry cycles, the eastern or Colorado end of Uinta Lake was separated from the Utah end. Consequently, three basins existed in which oil shale was deposited.

The deposits are over 3000 ft thick and are remarkably uniform in lateral extent. They are relatively flat-lying and are not known to be faulted or fractured.

The oil shale is resistant to erosion and forms the tops of plateaus, one each in Colorado, Utah, and Wyoming. The Colorado River and its tributaries have cut deep valleys through these plateaus.

The Piceance Creek Basin of northwestern Colorado contains the greatest thickness and highest grade of oil-shale deposits known in the United States. The mahogany ledge, that group of oil-shale beds, which averages more than 25 gal per ton for a thickness of more than 25 ft, lies under 1000 square miles of the Basin and can yield 100,000,000,000 barrels of shale oil.

Oil shale in the Piceance Creek Basin forms the Roan Plateau which rises sharply to altitudes above 9000 ft or as much as 4000 ft above the Colorado River. The surface of the plateau consists of gently rolling hills cut by deeply incised streams. The mahogany ledge crops out on the sides of the steep valley walls, as nearly vertical cliffs, 300 to 1000 ft below the surface of the plateau.

The oil shale from the Piceance Creek Basin is a magnesian marlstone which varies in color from light brown to black and resembles, in many respects, mahogany wood. It is thinly bedded, since 2000 to 5000 years of accumulation were required to form 1 ft; however, cementation is so complete that it breaks across bedding with a conchoidal fracture.

The rock is strong and tough but soft enough to be carved with a knife. Because of the calcium-carbonate content, it fizzes on the application of cold dilute hydrochloric acid.

When placed upon a fire, oil shale burns rapidly giving off a high heat. The volume of ash which remains after burning is as great as the original volume of the oil shale.

MINING FACTORS

Factors which affect the mining of oil shale are numerous.

The oil shale on the property of the Union Oil Company of California crops out at elevations between 7000 and 8000 ft above sea level. A tributary of the Colorado River, Parachute Creek, flows at an altitude of 6000 ft where it has cut through the oil-shale beds. The valleys of the various forks of Parachute Creek are less than 1 mile wide between the oil-shale outcrops; and the oil-shale peninsulas which separate the forks of Parachute Creek are 1 to 2 miles wide (see Fig. 1). The richer oil-shale zones form vertical and overhanging cliffs, the poorer oil shale often is covered by slopes of oil-shale rubble lying at angles of 35 to 40 deg.

Choosing the Minable Horizon. Cores obtained by the Bureau of Mines from the Naval Oil Shale Reserve indicate that the top of the Roan Plateau consists of shales, sandstones, and marlstones up to 1000 ft in thickness containing only thin beds of oil shale. An oil-shale measure 300 ft thick, averaging more than 15 gal per ton, is found below the surface beds. Directly below and contiguous with the 300-ft-thick oil-shale measure is the mahogany ledge, which on the Union Oil property is nearly 100 ft thick and averages more than 30 gal per ton. Additional oil-shale measures, which may average 15 gal per ton, lie under the mahogany ledge for a thickness of 300 ft.

The problems of choosing the minable horizon are as follows:

1 Shall the entire 700-ft thickness of oil shale, averaging more than 15 gal per ton, be mined?

2 Shall the 100-ft-thick mahogany ledge, averaging more than 30 gal per ton, be mined?

3 Shall some thin but rich portion of the mahogany ledge, such as an 8-ft-thick bed, averaging 50 gal per ton, be mined?

The 700-ft thickness probably can be mined by surface-mining methods after the 300 to 700 ft of overburden is removed. The total cost of removing the overburden and mining the oil shale would be very low, perhaps as low as 30 cents per ton of oil shale mined, or 2 cents per gal of shale oil recovered.

The mahogany ledge must be mined by underground methods since it is covered with 600 to 1000 ft of rock. Underground-mining costs are usually higher than surface-mining costs. but because oil shale is a uniform and strong rock that is amenable to mining on a large scale by the use of cost-cutting mechanical equipment, the mahogany ledge may be mined for as little as 50 cents per ton or 1.67 cents per gal.

A portion of the mahogany ledge 8 ft thick averages 50 gal per ton. Large cost-cutting mechanical equipment cannot be used as efficiently for mining an 8-ft bed as for mining the 100-ft-thick mahogany ledge. Therefore, mining costs might be considerably higher, perhaps more than $1.00 per ton or 2 cents per gal of shale oil recovered.

The cost of retorting becomes a factor in choosing the minable bed. Experience with retorting indicates that the cost of retorting a ton of 15-gal oil shale probably will be higher than of retorting 30-gal oil shale. If the problem of the coking of the 50-gal oil shale in retorts can be overcome, it is probable that a ton of 50-gal oil shale can be retorted as cheaply or more cheaply than a ton of 30-gal oil shale. Therefore, the retorting cost for recovering a gallon of shale oil from 50-gal oil shale is less than recovering shale oil from 30-gal oil shale and much less than from 15-gal oil shale. The total cost of mining and retorting oil shale per gallon of shale oil produced probably will be lowest when mining an oil shale yielding 30 or more gallons of shale oil per ton.

The minable horizon for a commercial oil-shale industry will be the mahogany ledge or some portion of it, but the decision cannot be made until more is known of the cost of mining and retorting for the various grades of oil shale.

Applying Mining Methods. The oil-shale beds lie flat, are uniform and continuous along a horizontal plane, and apparently have no important erraticisms such as rolls, faults, and shear zones which would interfere with continuous mechanized mining. Since the rock is strong, large openings can be made without fear of roof failure. The Bureau of Mines, at its experimental oil-shale mine near Rifle, Colo., has opened rooms 80 × 100 ft in horizontal area which stand unsupported without any sign of weakness or failure.

The most suitable method of mining probably will be from

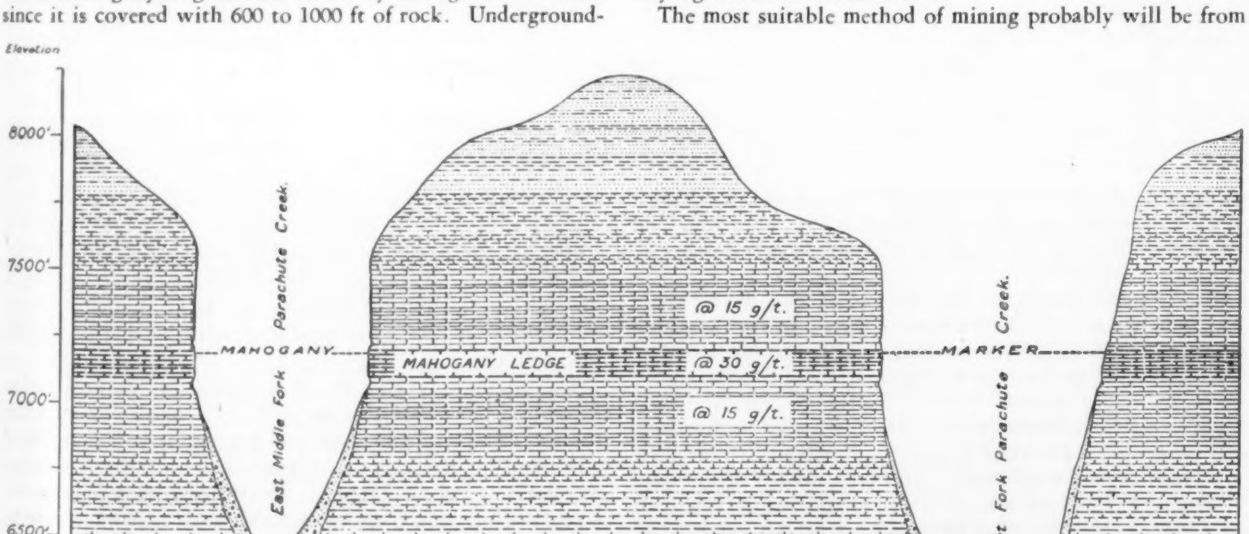


FIG. 1 OIL-SHALE FORMATION

(Vertical North-South section through Union Oil Company property on Upper Parachute Creek, Colo. Horizontal scale 4 times vertical.)

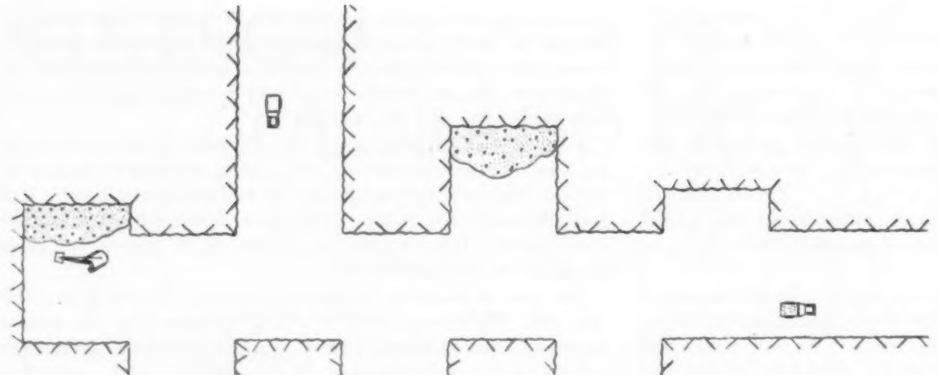


FIG. 2 MINING COLORADO OIL SHALE BY CONVENTIONAL METHODS

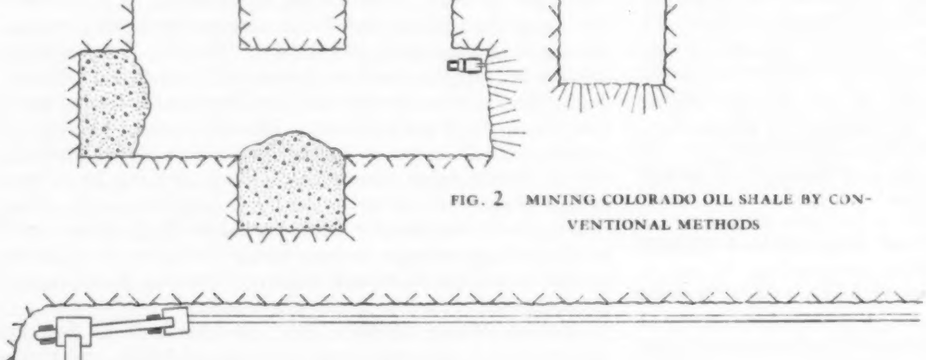


FIG. 3 ARTIST'S CONCEPTION OF THE CONTINUOUS MINING OF OIL SHALE

an open room, the roof of which will be supported by pillars. If the thickness of the bed to be mined is over 30 or 40 ft, the room probably will be mined as a quarry from a number of levels or benches.

Experimental mining to date has shown that the oil shale can be mined cheaply by the method shown in Fig. 2. Gang drills mounted on trucks or tractors are used for drilling. The drill holes are charged with dynamite and the charges are detonated. The blasted rock is loaded by electric-shovel loaders into large Diesel-driven trucks and hauled to the plant. All phases of this method of mining are adapted to oil shale from methods practiced at other mines throughout the country.

Because mining cannot be carried on by conventional methods at a cost of much less than 50 cents per ton, thought is being given to the development of new methods for mining oil shale. "The bituminous-coal industry has launched a $250,000 engineering program to design a machine that will mine coal cheaper and faster. The program's ultimate objective is a machine that will both cut coal 'off the solid' without the use of explosives and then load the coal continuously onto a conveyer . . . ."[1] The type of machine needed for very low-cost oil-shale mining is generally similar to the one required for coal mining and probably will utilize the principles of breaking and loading the oil shale continuously, Fig. 3. Since oil shale is ten times stronger than coal, the problem of designing the machine will be great. But because oil shale is self-supporting over large spans, the oil-shale mining machine can be built larger and more powerful than coal-mining equipment. The author believes that a continuous oil-shale mining machine is entirely feasible from a mining and a mechanical-engineering standpoint, and that, when the demand for such a machine is great enough, some manufacturer, in co-operation with an oil-shale mining company, will build it.

Handling Oil Shale. Because oil shale is of such a low value, transportation of oil shale has to be kept to a minimum. To do this the retorting plant must be built at the mine mouth and must be operated as a unit with the mine. Since the mine mouth will be on the side of the cliff, one to two thousand feet above the valley floor, the construction of a retorting plant and facilities will be expensive. As much of the plant as feasible will be placed underground. The problem of disposal of the spent shale, the volume of which is nearly as great as the original oil shale, is reduced considerably when the plant is at the elevation of the mine, since the spent shale need only be dropped, blown, or fed into the adjacent valley. The valleys of the branches of Parachute Creek through the Union Oil property are large enough to store all of the spent shale produced from the retorting of the mahogany ledge.

The oil shale will be mined and probably crushed underground. The crushed product will be delivered without interruption to a continuous-type retort where it will be retorted and burned. The burned or spent shale will be discharged continuously into the canyon. The valuable products are noncondensable gas and shale oil, both of which are fluid and can be piped easily from the elevation of the mine to holders, tanks, or pipe lines on the floor of the valley.

CONCLUSION

The commercial phases of the production of synthetic fuels from oil shale now are being explored. When the need of the nation for supplemental sources of liquid fuels is great enough, the author's company among others, will be ready to make up the deficit from oil shale.

[1] "Coal Industry Seeks Continuous-Mining Machine," *Mining and Metallurgy*, vol. 28, June, 1948, p. 329.

Studies on FLY-ASH EROSION

By M. A. FISHER[1] and E. F. DAVIS[2]

INTRODUCTION

One of the chief difficulties anticipated in the use of pulverized coal as a fuel for the gas turbine is the possibility of serious erosion of turbine blades and other metal parts by the suspension of fly ash in hot combustion gases. However, there appears to be no published information to date on the amount and nature of erosion by fly ash under actual turbine conditions. The Locomotive Development Committee of Bituminous Coal Research, Inc., has been vitally concerned with this problem in connection with the development of a coal-fired gas-turbine-driven locomotive. Therefore this committee has sponsored the work which is described in this paper, and which was carried out in the laboratories of the Institute of Gas Technology.

The erosion of metals through the impingement of solid particles suspended in a rapidly moving gas stream is an extremely complicated process which at present cannot be described in exact terms. It appears likely that, in most practical cases, erosion can take place through several different mechanisms, depending upon the properties of the eroded material and of the impacting particle, as well as upon local conditions at the microscopic point of impact. Under certain conditions, at least, it can be shown that the momentary pressure developed by the impact of a small particle at a velocity of several hundred feet per second may be sufficient to exceed the ultimate strength of any metal.[3] On the other hand, some experimental evidence indicates that, at least under some conditions, the amount of erosion depends primarily on the hardness of the eroded metal. Thus Gardner found that the erosion of turbine blades by water droplets in a special testing machine was a function of the hardness of the blade material, the harder metals being more resistant to erosion.[4] The importance of other factors, such as elasticity and fatigue resistance, is indicated by the erosion resistance of materials such as rubber.

The high operating temperature of gas-turbine blades introduces special problems in connection with erosion by solid particles. The oxide film which is formed on metal surfaces at high temperatures may well be more brittle and more susceptible to erosion damage than the underlying metal. If this surface film is removed by erosion, exposing more metal to oxidation, then the repetition of this process might lead to a very rapid loss of metal. In addition, the heterogeneous nature of some turbine alloys complicates the situation because the relatively minute particles of fly ash may show a preferential attack on some constituents of the metal structure, resulting in the weakening of stressed parts. In studying the erosion of turbine blades by fly ash at high temperatures, it is thus necessary to investigate possible structural changes and localized damage, as well as the over-all loss in metal weight.

Very little appears to be known about the dynamics of the movement of small suspended particles through a system as complicated as a gas turbine. Equations for the trajectories of particles in relatively simple flowing systems have been given by Lapple and Shepherd,[5] but no way is known of applying these results to the case of erosion in gas turbines. The actual paths of ash particles carried by the gas stream through the turbine will be a complicated function of gas velocity and temperature, particle-size distribution, and density of the particles, as well as the specific design of nozzles and blades and the velocity of rotation. It is impossible to predict how many of the fly-ash particles actually will strike the blades, at what relative velocity, and at what angle. For particles which actually impinge on a solid surface, the pressure exerted is highly dependent also on the shape of each particle and its elastic properties.

Since preliminary information was urgently needed on the probable course of erosion by fly-ash particles, experiments were designed to simulate turbine conditions closely. At the same time, the experimental apparatus was kept as simple and as flexible as possible, so that a rapid survey could be made of the chief variables which will determine the amount of erosion by fly ash in a coal-burning gas-turbine locomotive. As will be shown later, a number of interesting and unexpected results were obtained. In general, it appears that erosion can be controlled, but careful attention is required to several factors which were not previously known to be important.

EROSION-TEST APPARATUS

The type of apparatus used for running erosion tests under a variety of conditions is shown diagrammatically in Fig. 1. Compressed air, regulated by a pressure-reducing valve, was metered by a calibrated orifice. The air then passed through a heat-exchanger coil consisting of half a dozen turns of 1-in. 18-8 stainless-steel pipe, packed with porcelain balls to assist in heat transfer. The heated air was brought out of the furnace as shown for the introduction of fly ash through the vertical pipe C. The fly ash entered at a constant predetermined rate, and was dispersed into individual particles by the high-velocity jets of heated air issuing from three fine openings in a plug inserted in the air line just ahead of the dust feeder. The ash-laden air was returned to the furnace and proceeded to a miniature Aerotec dust-separating tube, enclosed in a stainless-steel cylinder as shown. Here the coarser particles of fly ash were separated from the air and dropped into the storage space E. The Aerotec dust separator used will be more fully described in a later section.

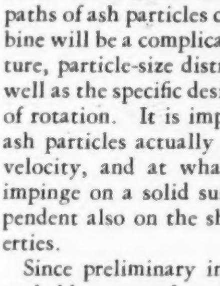


FIG. 1 APPARATUS FOR FLY-ASH EROSION TEST AT HIGH TEMPERATURE

(A, Compressed air; B, insulated electric furnace; C, dust feed; D, Aerotec dust collector; E, dust-collection chamber; F, thermocouple; G, pressure taps; H, nozzle; I, specimen.)

In some of the erosion tests, the apparatus was modified by extending a pipe from the Aerotec dust outlet through a hole in

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[2] Research Engineer, Institute of Gas Technology, Chicago, Ill.

[3] "Impact Cleaning," by W. A. Rosenberger, The Penton Publishing Company, Cleveland, Ohio, 1939.

[4] "The Erosion of Steam Turbine Blades," by F. W. Gardner, *Engineer*, vol. 153, 1932, pp. 146, 174, and 202.

Contributed by the Fuels Division and presented at the Annual Meeting, New York, N. Y., November 28–December 3, 1948, of The American Society of Mechanical Engineers.

[5] "Calculation of Particle Trajectories," by C. E. Lapple and C. B. Shepherd, *Industrial and Engineering Chemistry*, vol. 32, 1940, pp. 605–617.

the bottom of the furnace to a dust-storage hopper underneath. The pressure drop across the Aerotec tube was measured by a water manometer attached to the pressure taps G. The air temperature between the outlet of the Aerotec tube and the nozzle H was measured by a thermocouple F, inserted through the pipe wall and fastened by means of high-temperature silica cement.

At the beginning of the tests, the readings of the thermocouple F were checked against a fully shielded thermocouple placed in the air jet above the nozzle mouth. The interchangeable nozzles H were machined from stainless steel and served as supports for several types of specimen holders. A thermocouple F, as shown, measured the temperature of the erosion test specimen; since the whole apparatus was enclosed in an insulating structure, the temperature of the specimen was always close to the temperature of the fly-ash suspension in air. After striking the specimen, the air was exhausted through a pipe stack as shown. Part of the fly-ash content remained on various parts of the enclosure around the nozzle and erosion specimen; the remainder of the fly ash, after passing through a sufficient length of stack for cooling to a convenient temperature, was removed by a filter bag or an electrical precipitator. Thus all of the fly ash which passed through the apparatus was available for examination after each test.

In those tests where it was desired to test the effects of "raw" fly ash, that is, fly ash as received without any preliminary separation of the coarser particles, then the whole assembly containing the Aerotec tube separator could be removed and replaced by a simple duct which carried the fly-ash suspension to the nozzle. The furnace was heated electrically; both manual and automatic temperature control were conveniently used on different sets of apparatus. The relatively small demands of the apparatus for power and compressed air made it possible for several erosion tests to be run simultaneously. Erosion tests at room temperature were carried out also in apparatus similar to the foregoing, except that the furnace and insulation were omitted.

Fly-Ash Feed. Most of the erosion tests were carried out with samples of fly ash obtained from various power plants operating on pulverized coal. In all, ten samples of fly ash were used, representing various Eastern and Midwestern bituminous coals. Microscopic examinations, chemical analyses, and screen tests were carried out on the fly ash, but no detailed correlations of these factors with erosion could be obtained. However, a number of interesting general trends were observed, as will be described in a later section. It was determined that all of the fly ash used consisted chiefly of the spherical particles characteristic of fused ash, and that the general observations with regard to erosion remained valid for all of the various samples of fly ash used.

Differences in the particle-size distributions of the fly-ash samples were partially ironed out in those tests where an Aerotec tube was used to remove the coarser particles of fly ash before impingement upon the test specimen. The Aerotec tube is a cyclone type of dust separator. We have conducted tests on commercial models of Aerotec tubes of 2 in. and 3 in. diam, and have determined that these cyclones are capable of removing over 90 per cent of a fine pulverized-coal fly ash. Aerotec tubes were used in the erosion tests to determine the probable effect on turbine erosion if a high-efficiency separator is used to remove all but the finest particles of fly ash. The Aerotec tubes used in the erosion tests were $^3/_4$ in. diam and made of stainless steel. In preliminary tests, the conditions for operating these miniature tubes were established so as to obtain the same fly-ash-separating efficiency as with the larger Aerotec tubes. Thus at room temperature, the tubes were operated at 2 to 4 in. of water pressure drop, passing 2 to 3 cfm of air.

As an alternative to the use of the miniature Aerotec tubes, and to check the results, some of the erosion tests were also carried out with fly ash which had previously passed a regular 3-in. Aerotec tube. The procedure in these cases was to pass a quantity of fly ash through the larger Aerotec tube, collecting all fly ash which passed the separator in a large close-woven filter bag; this fine dust was then used in an erosion apparatus which did not, in such tests, include any fly-ash separator.

One of the most important requirements in a laboratory apparatus for testing dust erosion is to feed the dust into the air at a uniform rate in such a way that the dust is dispersed into individual particles, and the particle-size distribution does not vary with time. The type of dust feeder developed for the erosion tests is shown in Fig. 2. The operation of this feeder depends on the vibratory motion induced by a Burgess Vibrotool, and the rate of dust feed is controllable readily by adjusting the vibration amplitude.

The vibrator, which is commercially available, is a simple electromagnetic device which operates on 110-volt a c to give 7200 vibrations per min. Under the action of the vibrator, a steady stream of dust moves along the lower horizontal tube until it falls into the high-velocity jets of compressed air which disperse the dust into individual particles. The dimensions of the apparatus are not critical, except that the size of the horizontal dust-feed tube limits the range of feed rates available for any particular dust. Although the feeder may be constructed of smooth metal tubing, we have found it convenient to use glass feeders for pressures up to 30 psig, so that the movement of the dust can be observed readily and adjusted by manipulation of the amplitude control on the vibrator.

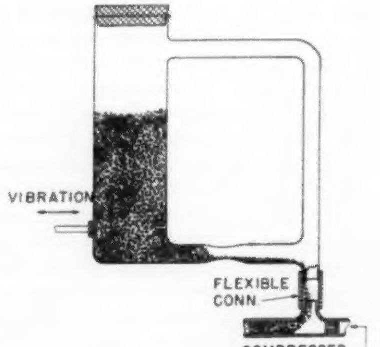

FIG. 2 DUST FEEDER

We have used a number of feeders of this type for feeding different kinds of dusts at rates varying from less than 0.1 gram per min to 50 grams per min. Where dust is to be fed into a system in which the pressure is close to atmospheric, it is convenient to modify the apparatus by omitting the pressure-equalizing tube and opening the top of the dust hopper to the atmosphere. In such cases, the dust is introduced into the test system through the suction opening of a compressed-air ejector which does an excellent job of dust dispersion. When first setting up a dust feeder for a particular apparatus, it is also convenient to make up a dust hopper with a number of interchangeable feed tubes, so that the best size of tube for the particular application may be chosen by trial. The feeder is then calibrated by collecting and weighing the portions of dust fed in a number of equal successive time intervals. Unless a dust is particularly free-flowing it is usually advisable to dry it throughly just before use, and to eliminate lumps by passing the dust through a sieve which is just coarse enough to pass all of the particles.

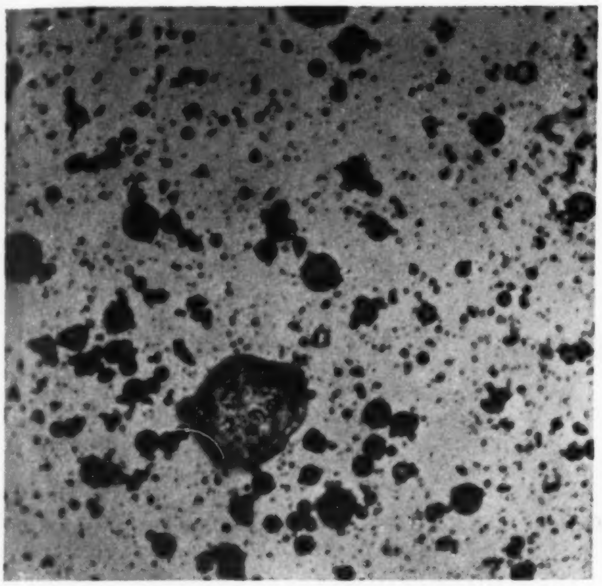

FIG. 3 PULVERIZED-COAL FLY ASH

(Sample prepared by precipitation from a suspension in air; ×200.)

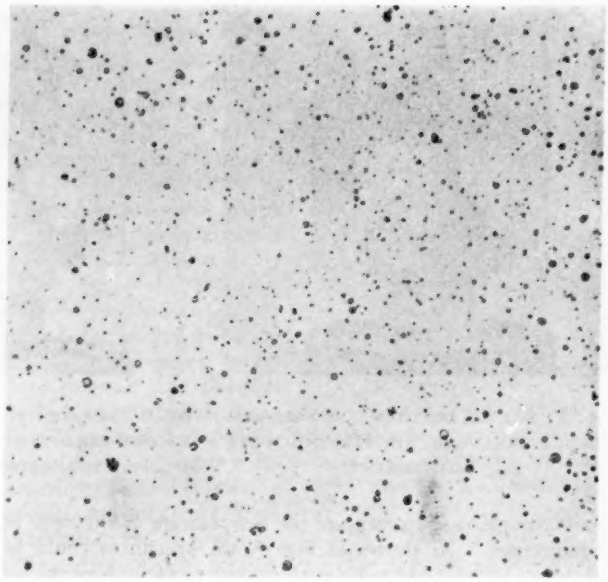

FIG. 4 FLY ASH IN AEROTEC-TUBE EXHAUST

(Sample prepared by precipitation from exhaust gas of an Aerotec tube operating at 970 F; ×200.)

The dust feeders used in the erosion tests had hoppers $2^1/_4$ in. diam and 12 in. high, with a capacity of about 600 g of fly ash per loading. The horizontal feed tube was 6 in. long and $^1/_2$ in. ID, with a smooth constriction to $^1/_4$ in. diam in the center. The constriction in the trough is an important feature because it produces a constant level of dust in the portion of the tube beyond the constriction and thus provides a constant rate of dust feed.

The question whether a suspension of dust in air is well dispersed into individual particles rather than clumps can be settled only by sampling and examining the particles as they actually exist in the suspension. For this purpose, a small laboratory type of electrical precipitator was used to obtain samples of the fly-ash dispersion produced by the dust feeder. The particles were deposited directly from the air onto a thin glass cover slip which could then be examined microscopically.

Fig. 3 shows a photomicrograph, at a magnification of 500 diam, of a sample obtained in this way from a fly-ash suspension produced by the dust feeder described. For purposes of comparison, Fig. 4 shows the appearance of fly-ash particles which have passed through an Aerotec-tube dust separator at a temperature of 970 F without being precipitated. Similar photomicrographs prepared by a number of special techniques were used throughout the erosion work to study the state of dispersion as well as the particle-size distributions and shapes of the fly-ash particles. It may be noted in passing that the largest particle visible in Fig. 4 has a diameter of about 7 microns, representing the maximum size of particle which escaped the dust separator under the conditions of this particular experiment. Other photomicrographs have shown conclusively that many particles smaller than this are removed by an Aerotec separator, depending probably on the position of the particles in the air stream entering the separator. The over-all dust-separating efficiency of the Aerotec tube in each erosion test was determined from the total weight of dust fed, the weight of dust caught in the Aerotec hopper, and the weight of dust recovered in the filter bag or electric precipitator beyond the erosion test nozzle and specimen.

Nozzles and Erosion Specimens. One of the chief factors determining the erosion of metals by fly-ash suspensions is the velocity of the impinging air stream. In this series of experiments, a range of velocities from 150 fps to 1040 fps was used, but most of the erosion tests at high temperature (1050 F to 1350 F) were run with air velocities between 500 fps and 850 fps. In the large gas turbines projected for locomotive service, the air velocities relative to the moving blades will be approximately 500 fps under normal operating conditions, but will vary considerably over the full cycle of operation. The air velocities were calculated for the erosion tests on the assumption of ideal conditions and were based on published tables of the properties of air. In view of the other experimental uncertainties, no attempt was made to apply any corrections for the effect of the suspended fly-ash particles on the air velocity. It was realized also that the actual velocity of the fly-ash particles at the moment of impingement is a complicated function of nozzle design as well as of particle size, density, and shape of the particles; in general, it cannot be assumed that the velocity of the particles is the same as that of the conveying air. The same situation of course will apply in the gas turbine and will be further complicated by the effects of centrifugal forces on the particle trajectories.

The nozzles used in the erosion tests were of simple convergent design, machined from 18–8 stainless steel, and readily interchangeable for the various experiments. The throat diameter varied from 0.101 in. to 0.275 in., and was determined by the desired air capacity which in turn was based on the volumetric air flow necessary to give the correct pressure drop and efficiency in the Aerotec dust separator. Although the rate of fly-ash impingement thus varied according to the conditions of the individual erosion tests, the final results were compared on the basis of the erosion produced per unit weight of fly ash impinged. The effects of absolute nozzle size were determined in a separate series of tests in which no Aerotec separator was used, and the nozzle diameter therefore could be varied at will.

A typical assembly of nozzle, specimen holder, and specimen is shown in Fig. 5. Here, the specimen is set with its surface perpendicular to the axis of the air jet. Also visible is the

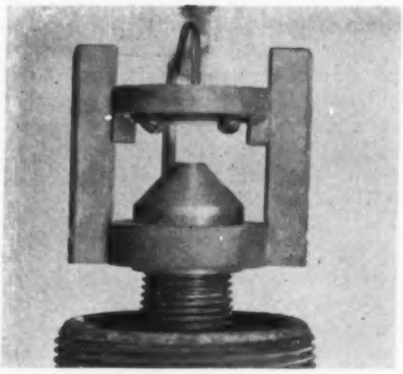

FIG. 5 NOZZLE, SPECIMEN, AND SPECIMEN HOLDER ARRANGED FOR PERPENDICULAR IMPINGEMENT

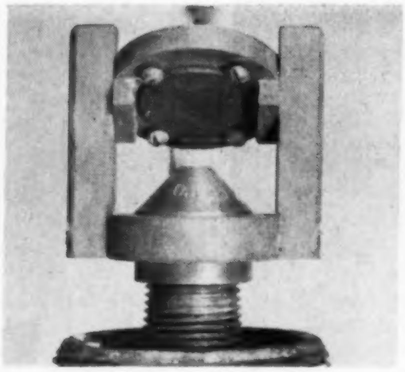

FIG. 6 NOZZLE, SPECIMEN, AND SPECIMEN HOLDER ARRANGED FOR IMPINGEMENT AT AN ACUTE ANGLE TO FACE OF SPECIMEN

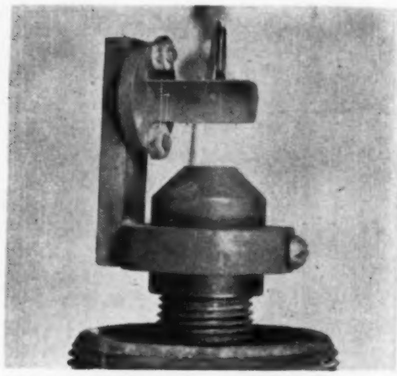

FIG. 7 NOZZLE, SPECIMEN, AND SPECIMEN HOLDER FOR SMALL TURBINE BLADES

thermocouple used to measure the temperature at the back of the specimen. As shown in Fig. 6, the specimens could be rotated to any desired angle with respect to the axis of the air jet. This view also shows the erosion test specimen consisting, in this case, of a disk of metal 1 in. diam and $^1/_8$ in. thick. Other test specimens were made in the form of thick rectangular blocks and were supported in a similar manner.

A simple support for small Vitallium turbine blades is shown in Fig. 7. The blades could be positioned at different distances from the nozzle and at various angles to the axis of the air jet in order to test the effects of fly-ash impingement on curved surfaces, such as will be found in an actual turbine.

Another type of erosion test specimen used consisted of turbine alloy pieces machined in the shape of standard stress-rupture test specimens. By means of a special yoke and lever arrangement, these specimens were kept under a continuous tension of 15,000 psi while being bombarded with fly ash at a temperature of 1350 F. The effect of fly-ash impingement was determined both by weighing the specimen before and after treatment and by running standard stress-to-rupture tests on the treated specimens and on similar blank specimens.

In order to eliminate variations due to the nature of the surface finish on erosion specimens, all test disks were given a standardized metallographic polish before erosion testing, and metallographic examinations were made on some of the specimens before and after fly-ash treatment. Records were kept of weight changes of the specimens during test, and dimensional changes were followed with sensitive gages and by microscopic measurements. Rockwell hardness measurements were also made. Care was taken not to introduce stresses in the process of cutting specimen disks, and specimens were given a stress-relieving heat-treatment whenever necessary. The metals used for the erosion tests included a carbon steel, cast Vitallium, and

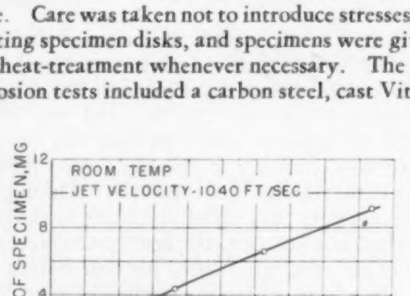

FIG 8 EROSION OF A VITALLIUM SPECIMEN AS A FUNCTION OF WEIGHT OF FLY ASH IMPINGED

the following special alloy steels: Timken 16-25-6, Universal-Cyclops 19-9DL; and Allegheny-Ludlum S-590 and S-588.

TEST RESULTS

The first series of erosion tests was carried out at room temperature using "raw" fly ash, that is, a sample of fly ash as obtained from the electrostatic precipitator of a large pulverized-coal-burning furnace. A preliminary set of experiments showed that the quantitative amount of erosion observed was highly dependent on a large number of factors which would have to be closely controlled. Thus Fig. 8 shows the amount of erosion of a Vitallium disk specimen as a function of the amount of fly ash impinged on it with a jet velocity of 1040 fps. The nozzle throat diameter was 0.101 in., and the specimen face was perpendicular to the axis of the nozzle and at a distance of $^1/_4$ in. from its mouth. At regular intervals, the air flow was shut off and the specimen was removed for weighing. It was then replaced accurately in its previous position and the air flow and dust feed were started again.

Obviously, under the conditions of this experiment, the rate of erosion decreased as the experiment proceeded. The reasons for this behavior were not investigated in detail, but a number of factors may have been involved. As erosion proceeded, a cavity was formed in the face of the specimen, with resulting changes in both the angle and distance of impingement. There was also the increased possibility for some of the fly-ash particles to remain temporarily in the cavity and thus cushion the impact of succeeding fly-ash particles. Moreover, metallographic examination of eroded Vitallium specimens showed that there had been a preferential removal of the softer components of the metal structure, leaving many of the harder dendritically arranged particles of a harder component protruding from the surface. The nonhomogeneous structure of the metal was confirmed by examining polished and etched surfaces of specimens before erosion.

Fig. 9 shows the appearance of a deep erosion pit in a Vitallium specimen, produced by the impingement of unseparated fly ash at 1040 fps and room temperature. The characteristic striated structure is clearly visible, and close examination reveals small grains of hard material adhering to the eroded surface.

The rate of erosion of Vitallium by unseparated fly ash at room temperature increased with increasing jet velocity, as shown in Fig. 10; the rate of increase was especially high at jet velocities approaching sonic velocity. Each value on this curve was obtained on a separate specimen, treated from a nozzle of 0.101 in. diam at a distance of $^1/_4$ in. The total amount

FIG. 9 EROSION PIT IN VITALLIUM SPECIMEN

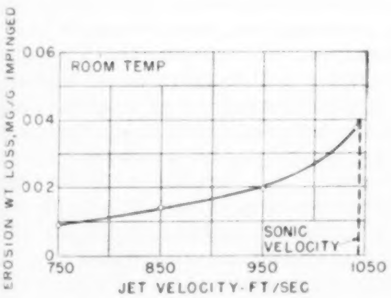

FIG. 10 EROSION OF VITALLIUM BY FLY ASH AS A FUNCTION OF JET VELOCITY AT ROOM TEMPERATURE

of fly ash impinged was about 130 g for each specimen, and the fly-ash concentration in the air stream was kept between 2 and 3 grains per cu ft.

The effect of nozzle-to-specimen distance is shown in Fig. 11 for a jet velocity of 850 fps at room temperature. As in the previous series of tests, the specimens were Vitallium disks placed perpendicular to the axis of the nozzle, and unseparated fly ash was used. The reasons for the rapid increase in erosion with increasing nozzle-to-specimen distance are not clear from the data available. The larger distances allow more time for accelerating the ash particles to the velocity of the air stream; at some critical distance from the nozzle mouth, the jet velocity must begin to decrease, and on approaching the specimen face the air velocity must undergo drastic changes in magnitude and direction. The lag between the air velocity and the velocity of an individual ash particle depends on the physical properties of the particle. With a heterogeneous sample of fly ash, the situation rapidly becomes too complicated to warrant an attempt at theoretical analysis.

The preliminary series of experiments with unseparated fly ash indicated the difficulty of any quantitative interpretation of erosion-test results unless a large number of variables were carefully controlled. Not only must the exact conditions of impingement be specified, but the erosion process must also be studied with due regard to the microstructure of the particular metal specimens used. The major effort of the erosion-test program was thereafter directed toward studying the behavior of a number of turbine alloys on bombardment with many kinds of fly ash under a variety of conditions likely to be encountered in actual coal-fired gas-turbine operation. Altogether, some 200 erosion tests were made, supplemented by physical and chemical studies of the fly ash and metal specimens. Space does not permit a detailed discussion of all the results, and only the general conclusions can be given.

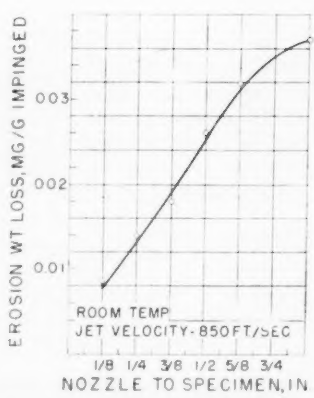

FIG. 11 EROSION OF VITALLIUM BY FLY ASH AS A FUNCTION OF DISTANCE BETWEEN SPECIMEN AND NOZZLE MOUTH

In contrast to the erosion tests carried out with raw fly ash at room temperature, when an Aerotec tube was used to remove the coarser particles of fly ash, it was found that a persistent deposit of ash particles was formed on the erosion targets. This deposit protected the surface of the specimen against erosion. However, even when the deposit was removed mechanically from the specimen face at frequent intervals during a test, it was found that the amount of erosion produced by the very fine ash particles which passed through the dust separator was less than 10 per cent of the erosion produced by the same weight of raw fly ash, the exact amount of erosion depending on test conditions and Aerotec efficiency. Since the Aerotec separator removed 90 per cent or more of the original fly-ash loading, it is obvious that the use of the dust separator resulted in a 99 per

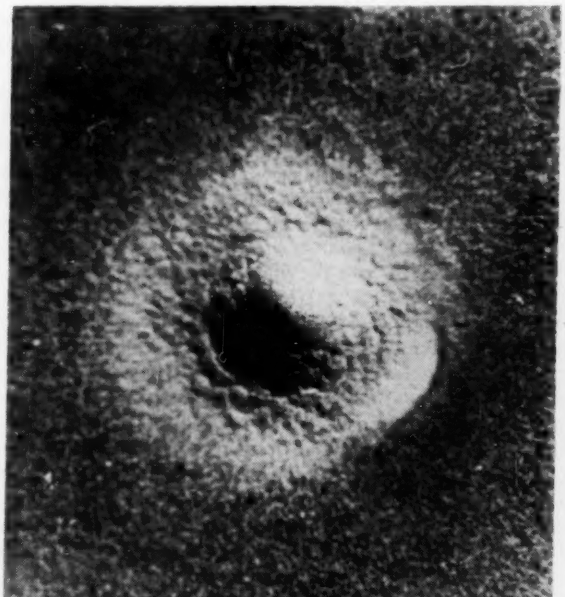

FIG. 12 FLY-ASH PRODUCED AT ROOM TEMPERATURE

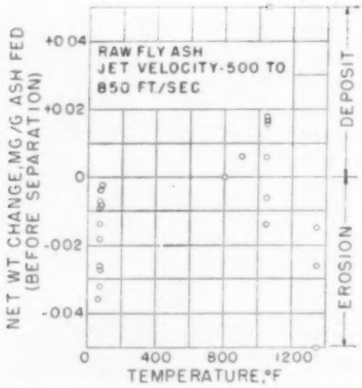

FIG. 13 NET WEIGHT CHANGE OF SPECIMENS IN EROSION TESTS AT VARIOUS TEMPERATURES

(Raw fly ash; various conditions of impingement; jet velocity, 500 to 850 fps.)

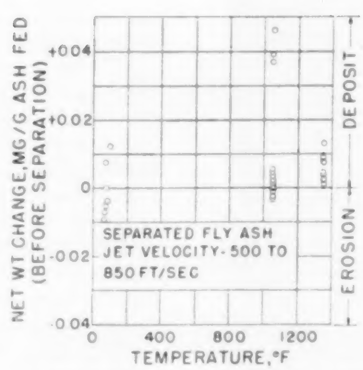

FIG. 14 NET WEIGHT CHANGE OF SPECIMENS IN EROSION TESTS AT VARIOUS TEMPERATURES

(Aerotec-separated fly ash; various conditions of impingement; jet velocity, 500 to 850 fps.)

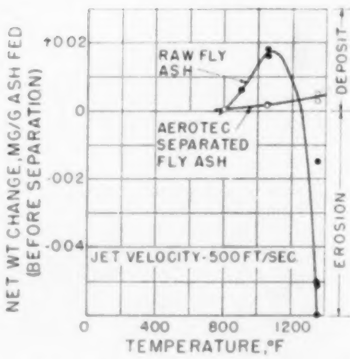

FIG. 15 WEIGHT CHANGE OF TIMKEN ALLOY SPECIMENS IN EROSION TESTS AT HIGH TEMPERATURES

cent or better reduction in erosion, based on the total amount of fly ash fed during a test.

The appearance of a typical heavy deposit of fly ash formed at room temperature by impingement at a velocity of 1040 fps is shown in Fig. 12. It was established that the formation of the deposits did not depend on the presence of oil or other impurities in the compressed air. However, pretreating the fly ash by heating it at 1400 F for several hours did reduce the tendency to form deposits and resulted in increased amounts of erosion. Since pretreatment of the fly ash removed the last traces of carbonaceous matter, this may indicate that the presence of relatively soft or plastically deformable material in the fly ash plays a role in deposit formation. However, the full explanation is apparently much more complicated, since there is evidence that the pretreatment by ignition also resulted in recrystallization and chemical reaction of some of the inorganic constituents of the fly ash. Moreover, many purely inorganic materials give deposits under similar conditions of impingement.

A series of tests were made in which thin deposits of fly ash were produced by impingement on thin glass cover slips. It was found that about the same proportion of fly ash adhered to the glass as to metal specimens. Microscopic examination of the deposits on the glass cover slip showed the characteristic, spherical, transparent particles of ash adhering to the glass surface. There was no evidence of fragments produced by shattering of particles either on the glass surface or in the air stream beyond the target, nor was there any appreciable number of particles which appeared as if they might have been flattened or plastically deformed by the impact on the specimen. The smaller ash particles adhered preferentially to the glass, and the primary deposit on the glass consisted mostly of particles smaller than about 2 microns. This is in keeping with the behavior observed in dust-sampling instruments and indicates that the same forces of physical adhesion are involved. Particles which have sufficient kinetic energy on impact to squeeze out the gas film at the specimen surface become attached to the surface, and adhere to the surface the more tightly the higher the surface-to-mass ratio of the particle.

High-Temperature Erosion Tests. The chief feature of all erosion tests at high temperature (800 F to 1350 F) was the formation of hard tenacious coatings or deposits on the specimens. The exact amount and nature of the deposits varied widely according to the fly ash used and the conditions of impingement. In many cases it was found that both deposit formation and erosion took place on different parts of the same specimen, so that the net result varied from a considerable loss of weight of the erosion test specimen under some conditions to rapid weight gains under other conditions. In general, it was found that deposit formation was associated with the impingement of relatively fine ash particles, smaller than about 10 microns diam, while coarser particles tended to remove any deposits present on the specimen face and to produce erosion of the metal.

While several series of erosion tests were carried out to determine some of the factors involved in erosion at high temperatures, only the general results will be taken up at this time. Fig. 13 shows the net weight change of various metal specimens after the impingement of unseparated fly ash under a variety of experimental conditions. Each point on the graph is the result of a separate erosion test. It is seen that while there was often considerable deposit formation by raw fly ash, particularly around 1000 F, in general, it may be expected that this type of fly ash would create a definite erosion problem.

Fig. 14 shows a similar graph for the results of tests carried out with Aerotec-separated fly ash. Here it is seen that the chief problem due to the fly-ash impingement was deposit formation rather than erosion of the metal specimen. The tests at room temperature which resulted in weight losses were all carried out with pretreated or ignited fly ash, as was also the test which showed the greatest weight loss at 1055 F.

The results of a set of high-temperature erosion tests carried out under uniform conditions of impingement is shown in Fig. 15, to illustrate the observed effect of removing the coarser particles of fly ash. At the top turbine operating temperature of 1350 F, the coarse particles removed any deposit which may have been formed faster than it could be built up by the relatively fine ash particles, resulting in a marked erosion. Where the fly-ash separator was used, there was no erosion, and the amount of deposit increased with increasing temperature.

High-Temperature Deposits. The deposits produced at high temperature consisted of a hard ceramic-like material ranging in color from a light tan, through various shades of reddish brown, to a dark-red almost black color. Most of the deposits adhered so strongly to the metal surface that they could be removed only with difficulty by using a sharp knife-blade. The main portion of the deposit was generally found in a roughly conical mound on the specimen directly opposite the nozzle mouth, but a thin coating extended over the whole surface of specimen disks 1 in. diam. Many of the deposits showed concentric rings of varying thickness and color. This structure

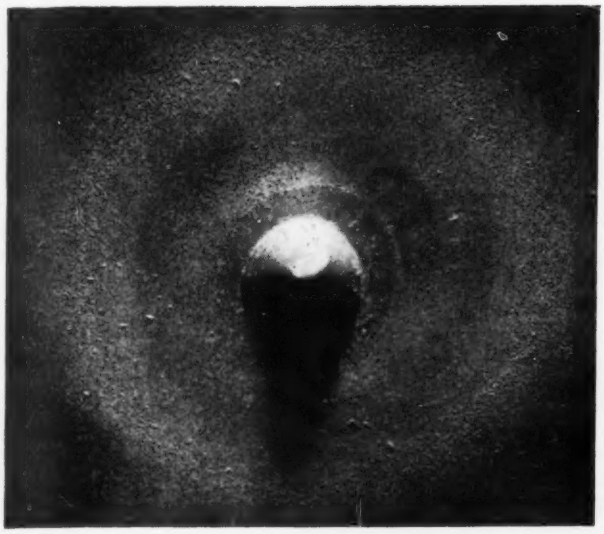

FIG. 16 HIGH-TEMPERATURE FLY-ASH DEPOSIT
(The raised conical deposit in center was surrounded by area containing a flat deposit.)

was apparently connected with resonance and vibration phenomena in the air jet, but no detailed investigation of the subject was carried out.

The general appearance and properties of the high-temperature deposits suggested that the fly-ash particles actually were sintered together, even at temperatures as low as 800 F. To check on the sintering temperatures of gross samples of fly ash under atmospheric pressure, samples of the various types of fly ash available were heated in a furnace to various temperatures between 800 F and 1600 F. Color changes in the fly ash were observed after heating at 800 F for 4 hr, indicating the beginning of chemical changes in the ash, but no appreciable sintering occurred below 1300 F. It appears therefore that the sintering of the fly ash in the deposits must be helped by the pressures developed during impingement as well as by the selective concentration in the deposit of the more plastic constituents of the fly ash.

Spectrographic analyses of a deposit formed by impingement of fly ash at 1055 F showed a higher concentration of calcium and lower concentrations of aluminum and silicon in the deposit material as compared with the original fly ash. X-ray analyses confirmed the fact that calcium sulphate showed a marked increase in concentration in high-temperature deposits. It was also found that the iron present in the form of magnetite in the fly ash was completely oxidized to hematite in the deposit.

The appearance of several typical high-temperature fly-ash deposits is shown in Figs. 16, 17, and 18. Although the deposits usually adhered tenaciously to the underlying metal, it was found possible to remove them completely by any one of several methods. Thus deposits could be removed completely by controlled impingement of ordinary fly ash either at room temperature or at 1350 F, without any appreciable damage to the metal specimens. An effective chemical method of deposit removal was found in the use of an inhibited acid solution which loosened the deposit on immersion for a few hours. After thus removing high-temperature deposits from specimens, it was found that the loss of metal was negligible and a good surface was restored. Sectioning and metallographic examination of the specimens showed no evidence of any harmful effects on the metal structure due to the fly-ash impingement or the chemical treatment.

ACKNOWLEDGMENTS

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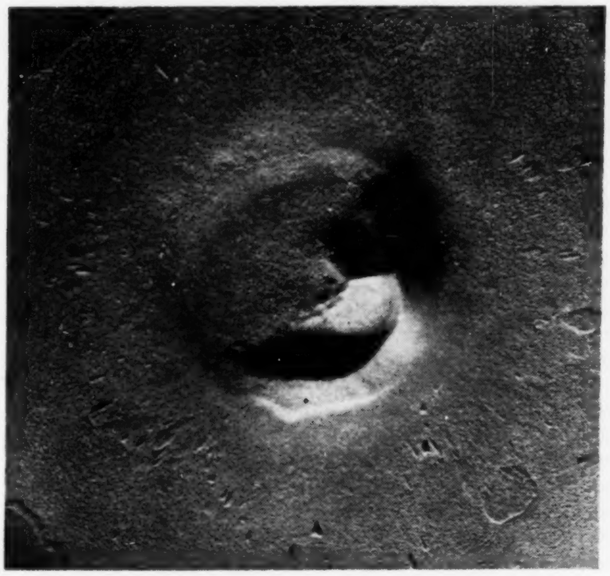


FIG. 17 HIGH-TEMPERATURE FLY-ASH DEPOSIT
(Entire surface of specimen was covered by deposit. Note irregular mound in center.)

FIG. 18 HIGH-TEMPERATURE FLY-ASH DEPOSIT
(Flat plateau in central region, shading off to a light film over remainder of specimen surface.)

Organizing and Financing CO-OPERATIVE RESEARCH

By ELMER R. KAISER

ASSISTANT DIRECTOR OF RESEARCH, BITUMINOUS COAL RESEARCH, INC., COLUMBUS, OHIO. MEMBER ASME

INDUSTRY ADOPTS RESEARCH

SEVENTY-FIVE years ago Thomas A. Edison began in a modest way and with limited funds to gather about him men of various talents to form the first industrial research laboratory. His laboratory at Menlo Park, N. J., became famous for many discoveries and inventions, but possibly the most important of all may yet be the industrial research laboratory itself.

Today, private industry operates 2500 research laboratories in which 135,000 persons (1)[1] are directly and indirectly creating new processes and products and improving old ones, as well as developing new information to help keep the fountain of knowledge from running dry. In this change-making function, the scientific personnel comprises 41 per cent; the technical personnel 26 per cent; and the balance, 33 per cent, nontechnical.

The term "industrial research" has become so broad as to include almost everything beginning with the search for and discovery of the laws governing the properties of matter and energy to the development and testing of processes, methods, and equipment. These classes of investigation commonly merge so that no sharp boundary can be traced between them. The National Research Council therefore defines industrial research as "the endeavor to learn how to apply scientific facts to the service of mankind" (1).

Currently, expenditures for research by industry are variously estimated at between \$450,000,000 to \$700,000,000 a year (2), or about twice the expenditure for 1940. The President's Scientific Research Board (3) estimated that the national research and development for 1947 (excluding atomic energy) was as follows:

Industry		\$ 450,000,000
Government:		625,000,000
War and Navy Depts.	\$500,000,000	
Other departments	125,000,000	
University		45,000,000
Other		40,000,000
Total...		\$1,160,000,000

A few companies spend as much as 5 per cent of their gross receipts for research, but $1^1/_2$ to 2 per cent is considered a good proportion by many (4).

SHORTAGES

Commendable as is the record of growth and accomplishment of science in industry, it is only a beginning. America and the rest of the world have merely sampled the fruits of industrial research; most industries have yet to make research the key to their future.

A top research consultant, T. A. Boyd of General Motors, states "... perhaps 90 per cent of all companies still have no research laboratories" (5). For example, of more than 17,000 manufacturing concerns whose gross sales exceed \$500,000 a year, less than 2500 have research laboratories A still smaller proportion of the 184,230 manufacturing establishments in 161 industries (6) have or could afford their own research facilities. Yet, the small and medium-sized companies with less than 250 employees each, produce one half of the dollar volume of manufactured products (7).

How are these companies to participate in and share the benefits of research?

Boyd gives two reasons for the inadequate number of laboratories in industry: "Many people still do not appreciate the importance of research, nor understand its tremendous potentialities. Another important reason lies in the belief that research is too costly and too complicated for any but large organizations to undertake."

Still another factor, equally vital in any attempt to increase the total research facilities rapidly, is the shortage of technically trained and experienced men and women to organize and conduct research. The demand for scientists and engineers still exceeds the supply, and will continue to do so for some time, despite the increasing numbers being recruited from the graduating classes of the colleges and universities.

Thus the combined limitations of management, money, and man power are forcing industry to look about for additional facilities, talent, and suggestions for growing research requirements.

CO-OPERATIVE RESEARCH AN ANSWER

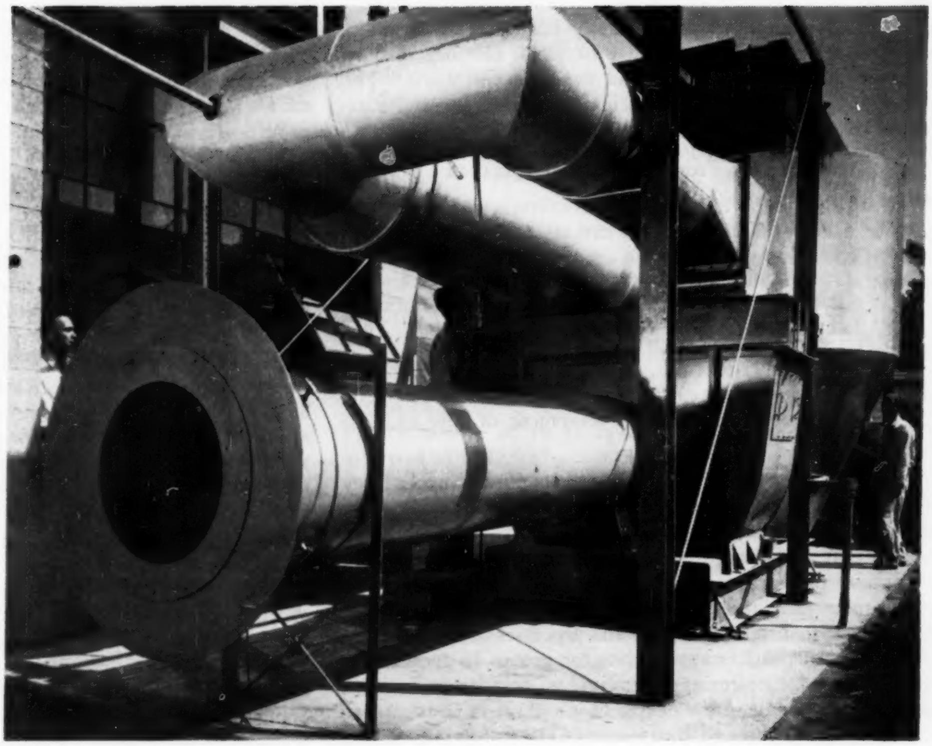
Individual companies have a choice today whether to (*a*) found their own laboratories, (*b*) sponsor private projects at established research institutes or at independent research and development laboratories, (*c*) sponsor or conduct research co-operatively with competitors or others, and (*d*) combinations of (*a*), (*b*), and (*c*). Of course, there is always the option of not participating in research at all, which is fast becoming recognized as another form of gambling in business with the odds against success.

The first two options have been discussed in most of the many books and articles on industrial research. Less known are the potentialities of co-operatively sponsored programs and how they are organized and financed. Once such programs are established, the technical work itself proceeds much as in company laboratories.

Under joint sponsorship, research on such subjects as "The Behavior of Steels in High-Temperature Steam Piping Service," can be undertaken by a single team of researchers for a group of companies at only a fraction of the cost and man power per company that would be required if each company made the study privately. Results obtained by a group are more widely and more readily accepted, and more experience can be applied through the committee of sponsors which administers the program. This is an example of the type of research that indi-

[1] Numbers in parentheses refer to the bibliography at the end of the paper.

Presented at a Joint ASME-AIME Meeting, White Sulphur Springs, West Va., November 3-4, 1948.



BITUMINOUS COAL RESEARCH, INCORPORATED, IS ONE OF THE LARGEST CO-OPERATIVE SPONSORS OF RESEARCH AT BATTELLE MEMORIAL INSTITUTE

(This apparatus is an experimental combustor used in a project aimed at the development of a coal-driven gas-turbine locomotive. The work is conducted under the auspices of BCR's Locomotive Development Committee and financed by railroad and coal interests.)

vidual companies would be glad to help support, but cannot justify doing alone for the benefit of an industry.

It is the purpose of this paper to discuss some of the factors and experience in co-operative research, including the organization of such undertakings, possible combinations of sponsorships, and dividing the costs among a sizable number of sponsoring companies. Many opportunities exist for the organization of sponsoring groups by those who will give time and effort to the work. It is a vital activity for our industrial progress and national strength in which technically trained men must take a leading role.

RESEARCH BY ASSOCIATIONS

Companies with common business problems are often members of trade associations, of which there are 11,000 in the United States. Of this number, 2600 are national and interstate organizations and 1900 are associations of business competitors in one industry (8). "Industrial research as to production or products" is one of the principal activities of 629 associations, while 752 associations include "commercial research as to markets or marketing."

Trade associations form a logical medium for organizing and sponsoring research programs for the industries they represent. Businessmen discuss openly in meetings of such co-operative organizations many industrial matters which would be considered trade secrets in some countries. Here research is a business matter and an important factor in the ability of an industry to meet competition.

Outstanding examples of 30 associations in industry which have their own laboratories are American Gas Association, Anthracite Institute, National Lumber Manufacturers Association, Portland Cement Association, and Underwriters Laboratories (8). Such laboratories are supported by dues from members and from additional contributions of funds and payments for special services.

Over 35 associations, including a few which operate their own laboratories, sponsor projects at universities and institutes (8). Among the industrial laboratories established to conduct research for industry on a not-for-profit basis are Armour Research Foundation, Battelle Memorial Institute, Mellon Institute, Midwest Research Institute, and Southern Research Institute. Several hundred independent research and development laboratories are also available for carrying out co-operative and private programs for large and small businesses.

Among government agencies, the National Bureau of Standards, Agriculture Department, and Bureau of Mines are three of many units (8) in which industries have working arrangements for research, sponsored by industry in government laboratories. For example, a study of acid mine drainage is being sponsored at the Bureau of Mines in behalf of the coal producers by Bituminous Coal Research, Inc. The basic studies of coal carbonization of American coals is another example of joint research with support over a period of years from the American Gas Association and now continued by the Bureau.

Many professional technical societies are also active in research. The American Society of Mechanical Engineers, for example, serves as a forum and co-ordinating agency. Seventeen special research committees are active, and support to date of $586,000, largely from industry, reflects the confidence industry has in such work.

The American Institute of Mining and Metallurgical Engineers sponsors research through The Engineering Foundation, but industry contributes directly to projects requiring additional funds. The Committee on Research is made up largely of representatives from industry.

The medium of an existing organization is not necessary for organizing a jointly sponsored project. Two or more individual companies with a common technical problem but no facilities to investigate it, today can obtain advice from competent sources and assistance in planning a research program which they may find economical to sponsor. Producers and

consumers, government and industry, universities and technical societies, trade associations and committees, manufacturers and suppliers, farmers and processors, can organize to undertake joint investigations and development work. The number of cases is increasing as scientists, engineers, and businessmen become aware of the opportunities.

TYPICAL TOPICS FOR CO-OPERATIVE RESEARCH

When the National Research Council investigated what management in nearly 100 companies expects of research (9), the five most common replies listed in their order of rating were as follows:

1 New products.
2 Maintenance of competitive technical position.
3 Cutting production costs.
4 Sales volume and net profit on new processes and products.
5 Serve production through development of new and improved processes.

The popularity of these expectations is confirmed by a survey on the "Research Requirements of American Industry" by the Evans Research and Development Corporation (2). The survey revealed that 47.6 per cent of industry invests funds in research to improve present products and processes, 42.3 per cent to develop new products and processes in their own fields, and 14.7 per cent to develop products and processes in other fields.

The types of projects appropriate for groups to sponsor are not necessarily the same as for individual companies, in some cases they depend upon the degree of initiative in the competitive race that members wish to retain. The following are generally suitable (8):

(*a*) Studies of raw materials.
(*b*) Extension of the commercial uses of products.
(*c*) Standardization of analytical procedures and improvement in methods and instruments of measurement.
(*d*) Improvement in safety and sanitation.
(*e*) Expansion of fundamental science in industry's field.

When members agree, the list can be extended with the following:

(*f*) Development of new products.
(*g*) Development of new processes and improvement of old ones.

Manufacturers usually agree to research which raises the general quality level of an industry's products.

It is not advisable to undertake or conduct projects that will:

(*a*) Interfere with the competitive activities of members.
(*b*) Have limited applicability.
(*c*) Be too far ahead of industry's thinking.

The ideal situation is (*a*) the knowledge it is planned to provide is needed, (*b*) that need is widely felt, and (*c*) the results obtained will be accepted immediately and used.

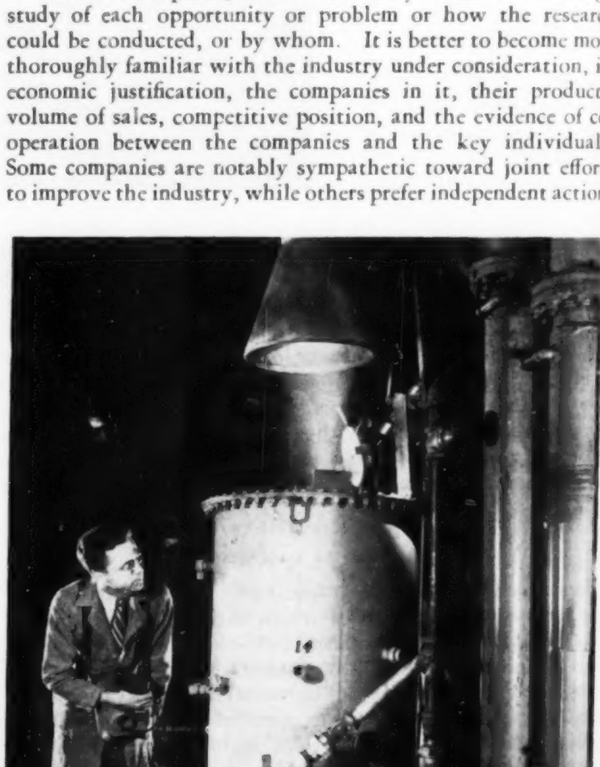
ORGANIZING A PROGRAM

Phase 1. Concept of a Project or Program. The background necessary to evaluate opportunities in research may be obtained through years of experience in an industry or through a formal survey. Usually an acute or chronic technical problem, with its adverse economic effects, is apparent in an industry, the solution of which at reasonable cost would spell profits. An investigation usually will disclose several such problems or needs, some of which are important enough to warrant a program. For example, the coal industry has urgent need for a machine that will mine coal continuously at low cost, an industrial coal burner that will automatically stoke itself and place the ashes into containers, a less expensive method of producing synthesis gas directly from coal, and a coal-burning locomotive of higher efficiency and greater service availability.

In metallurgy there are always problems in producing sound castings, in reducing corrosion, and in producing tougher metals and alloys for service at elevated temperatures. Every progressive industry has technical problems and opportunities; only dead industries do not.

Engineers and businessmen know the problems in their own industry, but may be too close to them by daily contact to see them in true perspective. An investigator from outside an industry, qualified by experience or association with research programs and business, can often see opportunities not apparent to those closely associated with daily operating matters. A fresh point of view and a knowledge of what other industries have done in similar circumstances are assets in conceiving new programs, because processes in one industry sometimes can be applied in another. Consulting research specialists are also available to suggest lines of investigation which are likely to yield valuable results. Many such specialists have laboratories and technical staffs ready to conduct all or parts of the investigations being considered.

In this initial phase, it is not necessary to make a thorough study of each opportunity or problem or how the research could be conducted, or by whom. It is better to become more thoroughly familiar with the industry under consideration, its economic justification, the companies in it, their products, volume of sales, competitive position, and the evidence of co-operation between the companies and the key individuals. Some companies are notably sympathetic toward joint efforts to improve the industry, while others prefer independent action.



AS PART OF ITS PROGRAM OF RESEARCH AIMED AT IMPROVEMENTS IN METHODS FOR THE MANUFACTURE OF GAS, THE AMERICAN GAS ASSOCIATION IS SPONSORING AT BATTELLE A STUDY OF THE FUNDAMENTALS OF THE WATER-GAS REACTION

(This is a small-scale generator for the production of water gas. It is used in the research to study reactions that occur in the generating bed.)

Out of this preliminary study should come definite and encouraging indications of worth-while opportunities and necessary research. Clear ideas of the possibilities of a plan of research must be formulated and expressed in a written statement of the factors just discussed. The statement may constitute the report of an investigator hired for the purpose, or it may be retained by the originator of the plan for his own information and guidance. The statement may raise questions and suggest more thorough surveys. It would be premature at this stage to present a cut-and-dried outline of specific projects to be undertaken.

Phase 2. Preliminary Discussions. The product of Phase 1 is hardly more than a basis for discussion. A period of incubation is necessary to develop a plan which can be presented to industry and warrant an investment. Usually, this can best be done by the originator in personal interviews with engineers and businessmen.

Entree must usually be arranged beforehand, and it is of considerable value to be representing an organization known for good works, as a member of a committee of a technical society or trade association, employee of a research institute, independent laboratory, university, or member company in an industry.

With a knowledge of an industry's needs and problems, the originator now sets out to interview the top executives and engineers who are most likely to lend a sympathetic ear and give sincere comments and suggestions. When businessmen learn that an engineer has come to seek their advice and suggestions on some ideas he has gathered for improving (or increasing the market for) the industry's products, for reducing costs, or for developing new processes, he can be sure of a welcome.

The trade and professional associations in the industry are vitally interested in any consideration given to the industry's welfare. The directors and officers are usually glad to assist in furnishing information and in suggesting avenues of approach to key individuals. Editors of the leading journals in the industry are also well informed and interested in the industry's future.

Valuable experience and information not known outside the company or industry, all bearing directly or indirectly on the particular subject under discussion, are often made available. Reminiscence sheds light on old ideas and helps to evaluate new ones. Informal discussion, in which it is wiser to listen than talk, is the best meeting of the minds. In companies which have research facilities, the director of research should be interviewed, as he will have ideas and advice to contribute.

At this stage, it is best not to let any portion of the plan "jell" or "freeze," and one must not be too definite as it leads to fixed positions and may develop early opposition. New ideas, and that includes good ones, are usually criticized and said to be unsound and impractical until they can be organized and expressed properly. The important criterion is not whether someone believes a program can be organized or will not be supported, but why? Constructive comments and advice are obtained from only a few, but they are all important. However, it is best to listen to everyone.

In this second phase, it is usually better to have individual interviews than joint meetings as they provide more freedom of thought and expression and permit confidential information to be given to the interviewer. During the preliminary discussions, it is well to determine who is who in the industry, which executives are held in highest regard and are well known for high integrity. Interest should be developed in attending an organization meeting should the preliminary discussions disclose a sincere desire on the part of a number to proceed with planning. The auspices under which the meeting could be called must be well established so as to prevent any feeling of factionalism. It is advisable to ask who would be interested in attending an organization meeting, and which men in each company would represent (*a*) management and (*b*) engineering or research.

Many will readily see the advantage of co-operative enterprise to develop the ideas, as few companies have the financial resources available to develop a project that will benefit an entire industry as much as the developer company.

Enough executives should be interviewed to obtain comments from at least the representative units of the industry or until the pattern of comments repeats itself often enough to show definite interest in proceeding to the next step.

Preliminary discussions may be held in small technical committee meetings, which can be a great saving of time, if those present are all interested in formulating a plan and have the necessary background and freedom of expression. This is suggested only where the originator is well known and has the full confidence of those invited. This procedure is usually followed in technical societies, except that only one project is usually considered at a time rather than a broad program.

Phase 3. Organization Meetings and Committees. When and if enough interest has been shown in the several major ideas that have been discussed, a meeting of a selected group of men can be called under the proper auspices to develop the ideas further and to take some co-ordinated action. Invitations should be extended to all companies, groups, and individuals who are believed to be of a co-operative frame of mind and likely to be helpful in organizing a program. A central location should be selected for the meeting and notice given at least two weeks in advance. A list of names of those invited, an agenda, and any memoranda that might well be considered beforehand should be sent with the invitations so as to keep everyone as fully informed as possible.

In a trade association the president is a logical one to call the meeting and to serve as chairman, but where no such association exists, one of the leading engineers or executives should be selected. A secretary should be designated, and minutes recorded for preparation and distribution later. The minutes are to be sent to those who attended and to others who were also invited. As the meetings are to be working meetings, it is best to limit the attendance to 25 or 30, and usually to a smaller number. However, there is danger in having too small a group and excluding some whose interest will be needed later.

The first group meetings to consider a joint research program may be either on the business or technical level. If a business meeting is called first, action may be taken on the advisability of a program, the probable cost, who should be invited to joint sponsorship, and who is to have charge of arranging the plan and program. The technical details are left to a technical advisory committee and an executive committee.

If a technical meeting is held first, objectives of the program can be outlined, a number of subjects listed, together with an estimate of cost and a suggestion for personnel organization.

In one type of program the first meeting is usually best made a technical one with the sole objective of analyzing the problems that have been suggested, and agreeing if possible on a limited selection of problems. To give point to the meeting, a talk by the originator or investigator should be presented in which a digest of the problems and a general summary of the comments is given without identity as to source.

Each of those present should be free to put forth his best comments and suggestions without committing his company. Little or no regard should be given to who would sponsor the work, except that it would be assumed it would be a joint project sponsored by the members of the industry and all will be invited to join. Little or no attention need be given in the

beginning to where the work may be done and what the cost may be. It is likely if attention is given to these details, conclusions may be reached which are entirely premature.

The presence of one or two top-management executives or prominent individuals usually has a good effect in giving moral support to the meeting and encouragement to the technical men.

When more problems or projects are suggested than could possibly be undertaken, a selection must be made in a democratic manner. The topics may be listed in the order suggested during the meeting and lettered consecutively A, B, C, etc. Each of those in attendance then lists the topics in his own order of importance or preference, after which the ballots are collected and the results tabulated. In this manner twenty projects can be reduced to five or ten.

Too much caution cannot be exercised in maintaining democratic procedures and every evidence of fair consideration throughout the organization of a co-operative program. In highly competitive industries, particularly, bad blood is easy to generate as many individuals whose co-operation is highly desirable are sensitive to their prerogatives.

Individuals and companies may have dissimilar ideas and interests about what should be done, and how, but agreement can be reached directly on some matters, and a suitable compromise usually can be reached on others. Fortunately, there generally are so many noncontroversial problems to solve in an initial program that others can be laid aside.

The culmination of Phase 3 is a written statement of the projects proposed, together with a list of those who participated in the meetings or those who endorse the program. A short statement of each project, a justification for research on it, and an estimate of the annual expenditure recommended for it will be required. The estimate of annual cost can be made by research directors or consultants with reasonable accuracy. Predictions of the time that will be required to complete a research project are of limited value and usually unnecessary. If the work is progressing satisfactorily, sponsors often find it desirable to continue on at least a year-to-year basis.

The statement should be written for management as a clear recommendation of the group of engineers or executives who have participated in the discussions and meetings up to this time.

Phase 4. Financing the Program. Those who will have the most direct interest in a research program are the logical sponsors and administrators of it. The public is the ultimate beneficiary, of course, but the public expects to pay for research indirectly through the purchase of goods and services. Notable exceptions are the public contributions to research on cancer and infantile paralysis.

Many combinations of interest have financed research in the past. The sponsoring companies need not all be in the same industry. Two or more units in each of the following classifications or in two or more of these groups comprise most of the cases:

1	Raw material producers	8	Government departments
2	Manufacturers	9	Technical societies
3	Transporters	10	Research associations
4	Trade associations	11	Research institutions
5	Granges	12	Universities and colleges
6	Consumers and users	13	Research foundations
7	Private individuals	14	Endowments

Numerous examples might be cited. For instance, Groups 1 and 3, comprising coal companies and railroads, are joint sponsors of a coal-mining-machine development under the Mining Development Committee of Bituminous Coal Research, Inc. Groups 2 and 10, comprising spreader-stoker manufacturers and the research agency of the bituminous-coal industry, are sponsoring a study of combustion in co-operation with one or two stoker users (Group 6), and a research institution, (Group 11). Groups 2, 6, 9, and 11, consisting of manufacturers, users and the ASME, are sponsoring research on the metallurgy of high-temperature steam piping at an established contracting laboratory.

A decision on the selection of participants sets the stage for a membership plan, on the basis of which the solicitations are to be made. The simplest plan is for each sponsor to pay the research laboratory the sum agreed upon and to have the laboratory pay all expenses. No contracts between sponsors, nor a special corporation, are thus required. The payments and any incidental expenses of their representatives are charged off as current operating expenses by the sponsors.

Complexities, such as changing membership, necessity for paid employees, sponsorship at several laboratories, and commercialization of inventions, necessitates the formation of a more formal organization. A corporation not-for-profit is the usual type as there is rarely any intention to declare dividends on income that may be derived. The conduct of the program requires additional dues annually from members, and any income from royalties is used to supplement the dues.

Membership dues, income from various sources, investments, and in general, property of corporations not-for-profit, are free from taxation. The state and federal regulations governing such corporations should be consulted carefully as there are other restrictions besides nonpayment of dividends.

Of course, a corporation for profit can be organized and stock issued for funds invested. The general preference in industry is the nonprofit corporation because the contributions can be written off as operating expenses rather than continued on in the books as capital expenditures. Any indirect profits are to be made by the sponsor companies themselves, and they expect to use the research results without paying royalties.

In drawing up a charter and by-laws, copies of those in effect by similar corporations can be consulted and adapted by a lawyer. A typical object and purpose is "to encourage, foster, and promote in any lawful manner the utilization of (products of industry) and of related equipment for and method of production, preparation, or utilization of (product of industry) by means of study, research, education, and other effort, or by developing equipment for and methods of production, preparation, or utilization of (product of industry) or any other lawful purpose."

All contributing companies may be classed as members, with voting power in proportion to total contributions to date. Powers and duties are vested in a board of directors, half of which are elected each year by the members. Officers elected each year by the board include a president, vice-presidents, secretary, and treasurer. In a small organization, the directors and officers are selected from the membership and serve without pay.

The research program may be outlined and administered by a committee which reports to the president and board. When the size of the program warrants, a director of research and an administrative staff may be employed. As a first approximation, an administrative cost of 10 per cent is reasonable.

BASIS OF PARTICIPATION

How much money shall each member company contribute? Shall each pay equally or in proportion to size of company?

In theory, an equitable proportioning of the cost is determined by the opportunity each participant has to benefit. Improvements in a product would benefit a large manufacturer financially more than a smaller one because he manufactures and sells more of them. Payments prorated on the basis of sales

AN AERIAL VIEW OF THE MAIN BUILDINGS OF BATTELLE INSTITUTE, COLUMBUS, OHIO
(Approximately 30 per cent of the Institute's industrial research is for co-operative sponsorships.)

volume are common. In this way companies ranging in size by as much as 100 to 1 can participate on a basis that is fair to all. In developing a new product, each participant would have a more nearly equal opportunity, in which case equal assessments might be made. This is also best when the companies are on a nearly equal footing in an industry, or where the total amount from each company is small. A compromise between proportionate and equal payments, in which a minimum and maximum fee are set, may satisfy the parties.

Quarterly or annual payments are convenient and are commonly made in advance.

Membership pledges or agreements can be simple signed pledges to contribute X-dollars a year in advance for Y-years for reports of research on subjects jointly agreed upon. More explicit legal documents can be executed if desired, binding the members and the research organization, but business firms prefer annual contributions without commitments to pay beyond one year at a time.

THE TIME FACTOR

Months and years of missionary work and the investment of thousands of dollars are required to organize the first research program in a sizable industry. Once the organization has been set up, and its value demonstrated, membership can be maintained and extended more easily. No rules can be given but a few examples will illustrate:

Case 1. A program administered by a Mining Development Committee of the bituminous-coal industry's research agency, and sponsored by 71 coal companies, railroads, and land companies. Objective: The designing of a machine for cutting and loading coal continuously in underground mining.

Phase 1	Date of conception	June, 1946
Phase 2	Preliminary discussions	7 months
Phase 3	Organization meetings	3 months
Phase 4	Financing	$11^1/_2$ months
	Initial fund raised	$258,000

Case 2. A program administered by a Spreader Stoker Research Committee and sponsored by seven stoker manufacturers and the bituminous-coal industry's research agency. Objective: To improve the utilization of coal on spreader-type stokers.

Phase 1	Date of conception	October, 1947
Phase 2	Preliminary discussions	4 months
Phase 3	Organization meetings	2 months[a]
Phase 4	Financing	4 months[a]
	Initial fund raised	$14,000

[a] Partial overlapping.

Case 3. A program administered by a Locomotive Development Committee of the bituminous-coal industry's research agency, and sponsored by nine railroads and five coal companies. Objective: To develop a coal-burning gas-turbine railroad locomotive.

Phase 1	Date of conception	Summer of 1944
Phase 2	Preliminary discussions	6 months
Phase 3	Organization meetings	4 months
Phase 4	Financing	1 month
	Initial fund raised	$1,113,000
	Total funds pledged	$2,754,000

Case 4. A program administered by a joint committee and sponsored by 14 stove manufacturers and the bituminous coal industry's research agency. Objective: To develop principles for smokeless stoves, ranges, and water heaters.

Phase 1	Date of conception	June, 1940
Phase 2	Preliminary discussions	5 months
Phase 3	Organization meetings	4 months
Phase 4	Financing	4 months
	Initial fund raised	$70,600
	Funds to date	$180,700

CONCLUSION

Organizing and financing co-operatively sponsored research programs is an activity of management that engineers are well equipped to conduct. By increasing the number of participants in a program, the benefits of research are extended, and the research talent conserved. The procedures are systematic and do not include high-pressure sales tactics.

A few words of caution may be advisable. Short cuts in the steps outlined, such as expecting to organize a program in one meeting, are often doomed to failure. Personal visits and trips are far more effective than mimeographed letters and outlines, and are necessary for results.

Patience and diligence, optimism, and confidence are vital because the slowness in which decisions are received may be discouraging. The author has never found organization work or financing to proceed for long on the momentum of a few favorable decisions of prospective sponsors. Hard work is necessary at every step, but the rewards of accomplishment are indeed satisfying to the organizer and to the participants.

In the words of Prof. Warren K. Lewis, "I feel that there is an unsolved problem as to how to handle the research needs of a small business, or at least one phase of those research needs, and that is the problem of competitive research in contradistinction to co-operative research. Co-operative research has been extraordinarily successful and has a large future ahead of it. By and large, there aren't many obvious rocks in the road (10)."

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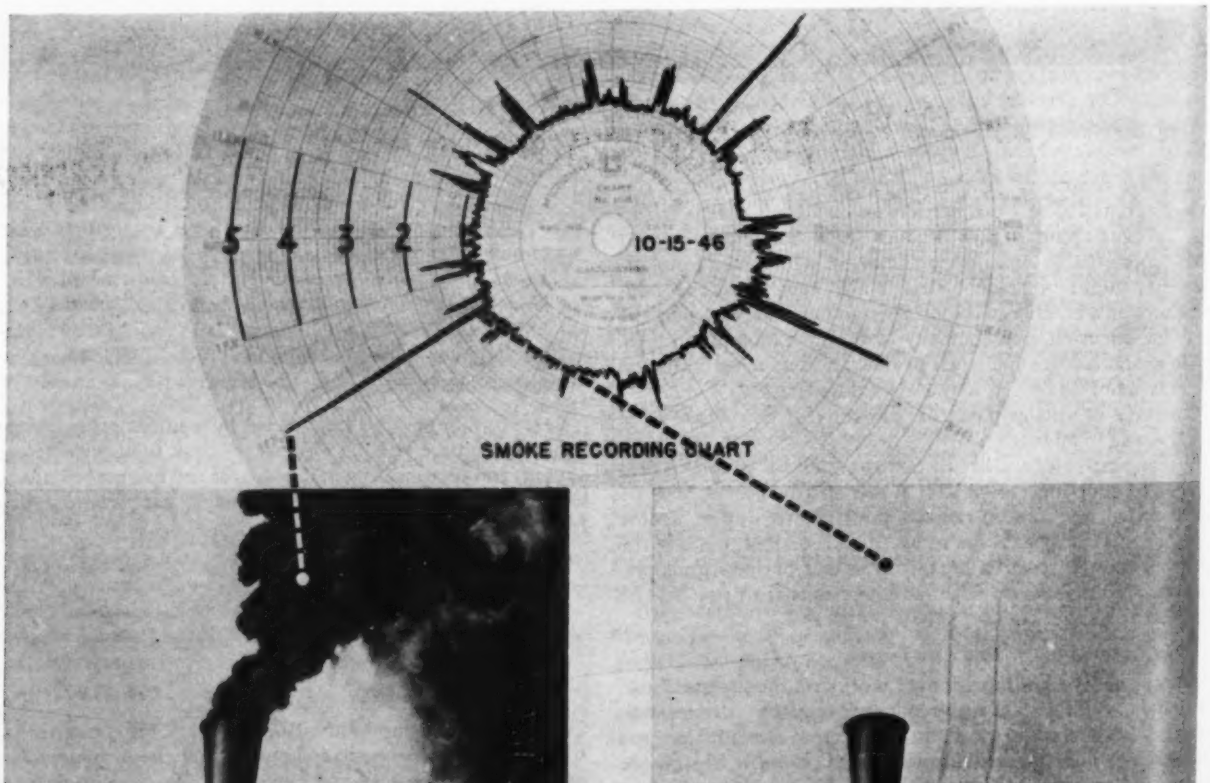

GRAPHIC PROOF OF THE EFFECTIVENESS OF MODERN OVERFIRE JETS IN ELIMINATING SMOKE FROM BOILER PLANTS

(Left illustration shows smoke emission without jets in operation; at right, 45 seconds after jets were turned on. The design and application of these modern overfire jets were effected under the sponsorship of Bituminous Coal Research, Inc., the national research agency of the bituminous-coal industry.)

HEAT-TRANSFER RATES

Experimental Determination for Heat-Absorbing Coils Buried in the Earth

By C. H. COOGAN, JR.

HEAD OF MECHANICAL ENGINEERING DEPARTMENT, THE UNIVERSITY OF CONNECTICUT. MEMBER ASME

THE rate at which heat can be absorbed from the earth by a copper tube buried horizontally in coil form at any depth from about 4 to 8 ft below the surface, through which a fluid is circulated, is of great importance in the design of ground coils for heat-pump systems. At present practically no fundamental information is available in the literature on this problem.

The experimental investigation, here reported, was initiated to obtain specific information on heat-transfer rates when the direct expansion of a vapor is used within the buried tube.

It is probable that the information obtained can be applied also to similar cases in which a liquid is circulated, especially when the resistance of the earth is the controlling factor in the heat transfer. The experimental results were obtained at Storrs, Conn., and should be of interest not only in the case of the heat-pump ground coil but also in similar problems of heat abstraction from the earth such as in the freezing of large earth dams and other similar problems.

DESCRIPTION OF PROBLEM

The diurnal variation in temperature at the surface of the earth produces an approximately sinusoidal yearly temperature variation, decreasing in amplitude with depth, with the maximum amplitude in temperature at any depth, displaced on the time axis. At Storrs, the temperature oscillations are practically eliminated at a depth of 40 ft with an isothermal at this point of approximately 54 F (1*a*).[1]

A long copper tube of small diameter is buried at essentially constant depth in the region just described at some particular depth between 4 and 8 ft. This tube serves as the evaporator of a compression refrigeration machine. The tube is supplied with refrigerant (Freon 12) through a spring-loaded expansion valve which maintains the coil at essentially constant pressure by metering in the proper amount of refrigerant. A small friction pressure drop occurs along the tube. With the expansion valve adjusted to produce an essentially constant pressure and hence constant temperature throughout the coil which is lower than the temperature of the surrounding earth, heat from the earth will flow through the tube wall and be transported by the circulated refrigerant above ground.

At the start of operation, the earth around the tube has a natural undisturbed temperature gradient perpendicular to the surface of the earth and temperature distribution, depending on location, depth, properties of the local soil, and the time of year.

After the coil has been operated for a considerable length of time, a quasi-steady state is attained, and the temperature distribution in the immediate vicinity of the buried tube approaches a quasi-steady-state distribution. Since the system is operated with the tube temperature held essentially constant, and hence since the temperature gradient in the immediate vicinity of the buried tube is greatest at the start, the rate of heat absorption per unit length of tube will be greatest at the start and will decrease with time, gradually approaching a constant value when steady state is reached.

Since the natural undisturbed temperature of the earth is continually varying with time, this will affect the amount of heat absorbed, particularly in extremely long runs.

Another factor which must be considered, since, in general, the coil will be of considerable length, is the temperature drop which occurs along the tube together with the friction pressure drop previously mentioned, when the refrigerant is in the wet region and evaporating. Recall that under certain conditions the refrigerant may go into the superheated region at the exit end of the coil and here the temperature, in general, will rise with the pressure drop. When this occurs, the portion of the tube in which superheating occurs is not as effective as a heat absorber.

The heat energy in flowing to the circulated fluid within the tube first flows through the earth, then through a film on the outer surface of the tube, then through the copper tube, and finally through a film on the inner surface to the circulated evaporating fluid. In some cases the earth around the tube may be frozen.

The major resistance to heat flow undoubtedly occurs in the earth, which is, in general, a material of low thermal conductivity. The resistance of the thin copper tube is negligible when compared with the other resistances in the system. Exact computation of the internal film resistance in the tube is impossible since the refrigerant is, in general, in the wet region, and certain refrigerant properties are not accurately known. However, since the refrigerant is close to saturation at exit, and since the properties are known under these conditions, an approximation can be made for the exit end of the coil, and it is probable that the conditions along the coil will not vary from these by more than a factor of from 3 to 5.

Under saturated-vapor conditions, the Prandtl number is approximately 0.85, and the Reynolds number about 108,000. Application of the Nusselt equation (2) for these values indicates a film coefficient of about 200 Btu hr^{-1} ft^{-2} deg F^{-1} for the inside of the tube. Hence it is clear that the resistance of the earth is the controlling factor.

It is evident then, that the major factors which affect the rate of heat absorption of a tube buried in the earth, through which a vapor is circulated, are as follows:

(1) Physical properties of the local soil. (2) Duration of operation, i.e., whether nearest to transient or quasi-steady state. (3) Temperature distribution in the close proximity of the tube at the start and natural temperature changes in the earth due to seasonal variations. (4) Temperature at which the coil is operated, since it affects the temperature difference between the undisturbed earth at coil level and the coil, and also determines whether or not the moisture in the soil will be frozen around the tube. (5) Outer tube diameter. (6) Coil length. (7) Depth below surface. (8) Tube spacing, i.e., where more than one tube is placed in close proximity in the same trench and the tubes are operated concurrently. (9) Parallel or series operation of tubes having small spacing. (10)

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Heat Transfer Division for presentation at the Spring Meeting, New London, Conn., May 2–4, 1949, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Under intermittent operation, the rate of heat recovery of the earth around the buried tube.

It should be emphasized that the moisture content of the soil, and hence the many factors which affect it, such as percolation of rainfall or melting snow, or moisture migration due to temperature gradients, also will be of major importance. It is probable that the moisture content of the earth is the most important single factor in the whole problem, since it strongly affects the thermal conductivity of both unfrozen and frozen soil, and also can carry heat energy along as it moves through the soil. The moisture in freezing also allows the heat of fusion to be recovered. This is not likely to be of importance except in runs of short duration owing to the slow progression of the freezing radius and accompanying slow absorption of the fusion energy.

EXPERIMENTAL METHOD

In order to determine the heat-transfer rates experimentally, a series of seven different coils were buried as shown in Fig. 1. Each independent coil circuit was approximately 150 ft long on the horizontal plane in the earth. The coils were located at three different levels with each level having at least one coil with a common diameter, and at the lowest level there were three coils having tubes of different diameters. At the middle level, the coils were manifolded in a manner which allowed two coils to be operated in series or parallel at three different center-to-center distances.

The heat absorbed was determined from pressure and temperature measurements at the inlet and outlet ends of the coil, which, together with the quantity of Freon circulated, as determined by a heat balance on the insulated condenser, allowed the heat-absorption rates to be calculated by reference to a property table for Freon 12.

By means of temperature measurements made with the thermocouples located around the buried tubes, as shown in Fig. 2, and the measured heat-absorption rates, the thermal conductivity of the soil around the tubes was computed.

The thermal conductivity of samples of the soil, taken from around the coils at installation, was determined in the laboratory by a method similar to that used by Shannon and Wells (3). By this method the thermal diffusivity was obtained, and the thermal conductivity computed after the specific heat and density of the sample had also been determined.

Starting on June 19, 1947, and running through August 12, 1947, a preliminary set of runs was made in which all the coils were operated. During the greater portion of this period heat was being removed from the earth. On August 12, 1947, the unit was shut down and the earth around the buried tubes

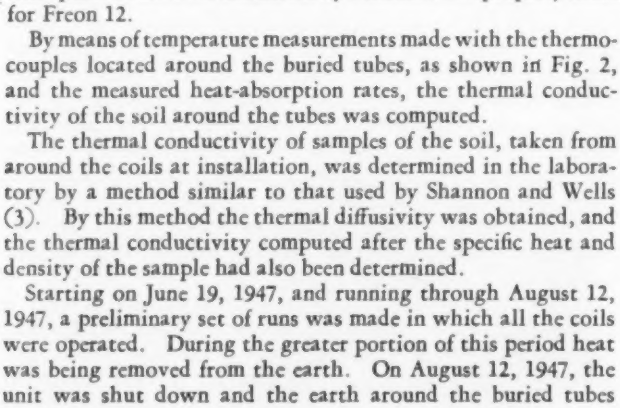

FIG. 1 PLAN VIEW OF GROUND COILS
(Nominal vertical and horizontal dimensions shown in Fig. 2.)

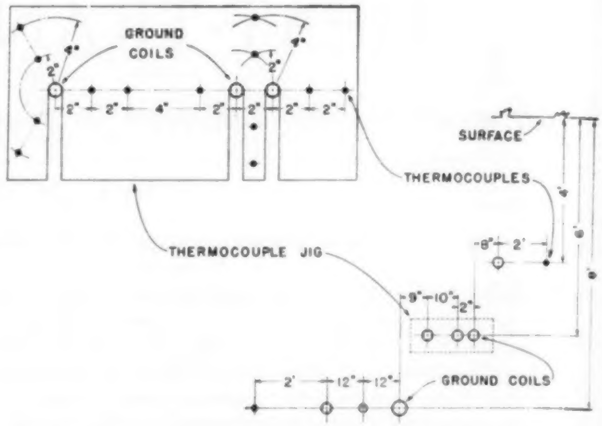

FIG. 2 LOCATION OF GROUND COILS AND THERMOCOUPLES
(4 ft averaged 3.70 ft; 6 ft averaged 5.68 ft; 8 ft averaged 7.34 ft.)

allowed to recover most of the heat which had been removed.

The unit was started again on October 14, 1947. From October, 1947, through January, 1948, a number of effects such as distance between tubes, depth, tube diameter, were studied in a series of short runs, always, however, loading one coil approximately in proportion to the heating load in degree-days. During this period the coil temperature in each case was kept close to freezing and in most cases slightly above freezing. A long run, starting early in January, 1948, indicated that the heat removal, without going to a coil temperature considerably below freezing, would be impractical with the earth temperatures prevailing in southern New England. It was decided, therefore, that for the remainder of the season the coil temperature would be lowered to between 15 and 20 F and the moisture in the earth around the tubes allowed to freeze. For the period from February, 1948, through early July, 1948, a series of long runs were made, which are reported herewith. In each run the coil was operated continuously for a period of about 1 month.

The soil in the region is not completely homogeneous and uniform throughout, and the moisture content probably varies somewhat with time. Measurements made, which are shown in Table 1, indicate, however, that increase in moisture content increases thermal conductivity, also that frozen soil has a higher thermal conductivity than unfrozen soil.

MEASURED HEAT-TRANSFER RATES

Fig. 3 shows the heat absorbed by a single tube coil buried at an average depth of 5.68 ft and having an outer tube diameter of 0.875 in. ($^3/_4$ in. nominal), during February.

Table 2 shows the heat absorbed by a single tube coil buried at an average depth of 7.34 ft, and consisting of a tube with outer diameter of 1.375 in. ($1^1/_4$ in. nominal), during March.

Fig. 4 shows the heat absorbed by the same coil as the test in Fig. 3, but during April. Note that coil temperatures and ground temperatures have changed somewhat.

Fig. 5 shows the heat absorbed by two coils, each having a tube of 0.875 in. OD, and located 12 in. apart, center to center in the horizontal plane, at an average depth of 5.68 ft. The two coils were operated in series, and results are for May.

Fig. 6 shows the heat absorbed by the same two coils used in Fig. 5, but for parallel operation during June.

RATE OF PROGRESSION OF FREEZING ZONE

Samples of the soil containing moisture were frozen in the laboratory, and it was established definitely that freezing in the local soil occurred at 32.0 F.

TABLE 1 THERMAL CONDUCTIVITY OF LOCAL SOIL

Per cent moisture (dry basis)	Average temperature of test, deg F	Thermal conductivity, Btu/hr-ft-deg F
0.8	62	0.218[a]
8.37	60	0.637[a]
10.3	60	0.669[a]
16.2	62	0.889[a]
High[c]	48	1.5[b]
High[c]	27	2.0[b]
High[c]	29	2.42[b]

[a] Test made in laboratory.
[b] Test made in earth around tubes.
[c] Samples taken around tubes at intervals of about a year gave moisture contents of between 30 and 41 per cent (dry basis).

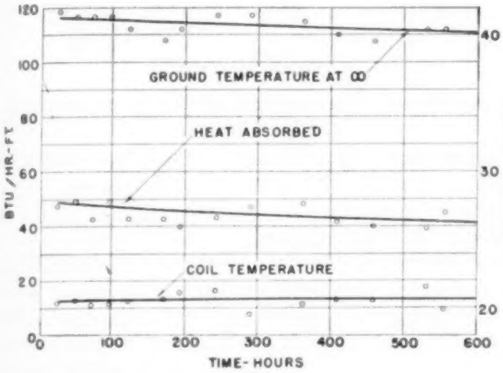

FIG. 3 HEAT-ABSORPTION VERSUS TIME; SINGLE TUBE

(Freezing moisture in soil around tube. February. North jig: Average temperature, 2 in. from tube, at start 35.9 F; at end 28.6 F. North jig: Average temperature, 4 in. from tube, at start 37.3 F; at end 30.6 F. South jig: Average temperature, 2 in. from tube, at start 31.1 F; at end 26.4 F. South jig: Average temperature, 4 in. from tube, at start 33.2 F; at end 28.4 F. Ground temperature at ∞ means undisturbed ground temperature at coil level.)

TABLE 2 HEAT ABSORPTION VERSUS TIME

Single—1¼-in-diam tube (1.375 in. OD); 7.34 ft depth

Heat absorbed, Btu/hr-ft	Elapsed time, hr	Freon 12 circulated, lb per hr	Undisturbed earth temp, 7.34 ft, deg F	Average coil temp, deg F
...	0	...	42.3	...
52.6	100	2.57	41.7	16.5
49.1	220	2.42	...	16.5
47.4	420	2.37	40.8	16.5
45.1	530	2.28	41.8	16.5
44.9	698	2.31	43.2	16.5

NOTE: This coil had not been operated since December 15, 1947, when it was last operated and then for only 122 hr. Coil located 22 in. away from this coil had been operated 1900 hr during the 1947–1948 season when this test was started. Estimated temperature of earth around 1¼-in. tube at start of test 40 F.

The rate at which the freezing radius (32 F isotherm) moves out from the buried tube is shown in Table 3 for the tests in Figs. 3 and 4. It is clear from Table 3 that the freezing zone progresses slowly indeed, since it requires approximately 114 years of steady operation to freeze a 30-in-diam cylinder around the tube.

The cumulative total heat absorbed from the start, from heat of fusion, and the rate heat is absorbed from the heat of fusion only, are shown in Fig. 7.

Examination of these data and comparison with the heat-absorption rates in Figs. 3 and 4 clearly show that the heat obtained from the heat of fusion of the moisture is extremely small after 800 hr of steady operation, at which time it represents less than 3 per cent of the total heat-absorption rate for the buried tube.

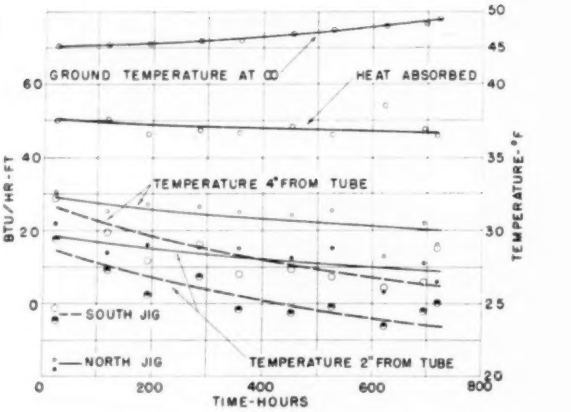

FIG. 4 HEAT ABSORPTION AND TEMPERATURES VERSUS TIME—SINGLE TUBE

(Freezing moisture in soil around tube. April. Average coil: Inlet temperature 18.6 F; outlet temperature 15 F.)

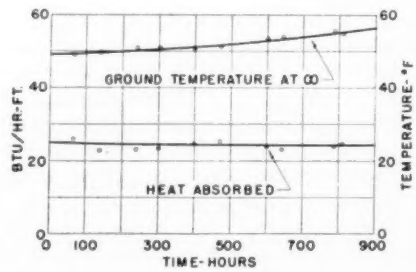

FIG. 5 HEAT ABSORPTION VERSUS TIME; SERIES OPERATION OF 2—¾-IN. TUBES, 12 IN. APART

(Average coil: Inlet temperature 17.1 F; outlet temperature 40.8 F. North jig: Average temperature, 2 in. from tubes, at start 34.7 F; at end 36.1 F. North jig: Average temperature, 4 in. from tubes, at start 34.8 F; at end 36.1 F. South jig: Average temperature, 2 in. from tubes, at start 33.2 F; at end 31.4 F. South jig: Average temperature, 4 in. from tubes, at start 33.9 F; at end 34.9 F.)

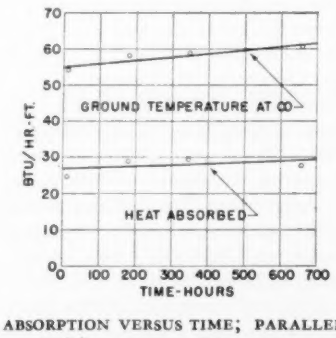

FIG. 6 HEAT ABSORPTION VERSUS TIME; PARALLEL OPERATION OF 2—¾-IN. TUBES, 12 IN. APART

(Average coil: Inlet temperature 17.9 F; outlet temperature 38.4 F. North jig: Average temperature, 2 in. from tubes, at start 36.1 F; at end 27.4 F. North jig: Average temperature, 4 in. from tubes, at start 36.1 F; at end 30.4 F. South jig: Average temperature, 2 in. from tubes, at start 31.4 F; at end 55.3 F. South jig: Average temperature, 4 in. from tubes, at start 34.9 F; at end 56.5 F.)

Measurements of the temperature at a distance of 2 in. from the tube center, after the test reported in Fig. 3, show that about 110 hr were required for the melting radius to move in from a radius of 5.5 in., where it was located at the end of the test, to a radius of 2 in.

TABLE 3 RATE OF FREEZING-RADIUS MOVEMENT OUT FROM BURIED TUBE

Test	Elapsed time, hr	Radial distance from tube center to freezing zone, in.
Fig. 3	20	2
Fig. 3	200	4
Fig. 3	556	5.5
Fig. 3	10,000[a]	9.0[a]
Fig. 3	1,000,000[a] (114 years)	15.0[a]
Fig. 4	10	1.9
Fig. 4	120	4.0
Fig. 4	718	6.0
Fig. 4	10,000[a]	8.8[a]

[a] Extrapolated.

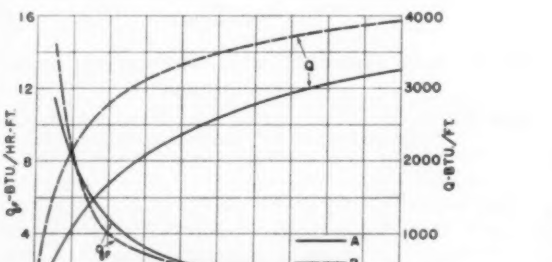

FIG. 7 CUMULATIVE TOTAL HEAT ABSORBED AND RATE OF HEAT ABSORBED FROM HEAT OF FUSION ONLY VERSUS TIME

(Q = total heat from fusion, q_F = heat-absorption rate. Curves A = test of Fig. 3; curves B = test of Fig. 4; assumed moisture 30 lb-ft^{-3}.)

TEMPERATURE DISTRIBUTION AROUND BURIED TUBES

The measured temperatures around the buried tubes during the test reported in Fig. 4 are shown in Fig. 8.

It is clear that the changing earth temperature, at tube level, has affected the temperature distribution only in so far as the 8-in. radius at the end of 718 hr. From these curves there would appear to be a considerable lag in the progression of temperature changes in the earth toward the tube center.

Under steady-state conditions the line-sink theory (4, 1*b*) appears to agree reasonably well with the experimental results of measured heat absorption in a ground coil.

This theory considers the heat-absorbing tube as a line sink which has a constant-temperature isotherm coincident with the outer tube surface. The surface of the earth is also assumed flat and to be at a constant temperature. In order to satisfy the boundary conditions, a line source of equal strength is assumed located above and equidistant from the surface of the earth. This theory can be extended to one, two, or more parallel tubes buried at the same or several depths.

Comparison of the experimental results with this theory indicates fairly close agreement so long as the soil remains unfrozen. Line-sink-theory predictions are shown in Table 4.

CONCLUSIONS

A moist soil is superior to a dry soil in so far as the heat-absorption rate of a buried tube is concerned. This is due to the higher thermal conductivity of moist soil in comparison with dry soil. This same relationship holds for both unfrozen and frozen soil.

Although at first glance it might appear that the heat obtainable from the fusion of soil moisture would be fairly large, it is clear from the experimental results that this factor is of little importance after 200 hr of steady operation and practically

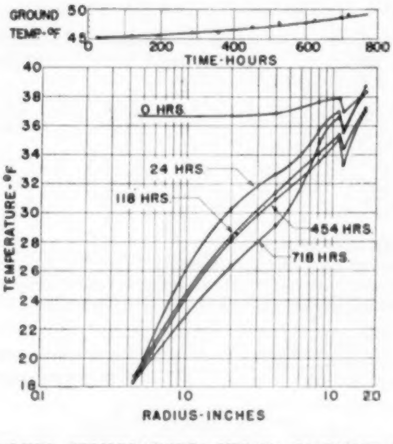

FIG. 8 OBSERVED TEMPERATURES VERSUS DISTANCE FROM TUBE CENTER AT NORTH JIG

(Same test as Fig. 4. Ground temperature is undisturbed ground temperature at same level as tube.)

TABLE 4 LINE-SINK-THEORY PREDICTIONS

Number of parallel tubes — Line-sink-theory prediction

One $$q_1 = \frac{2\pi k(T_G - T_C)}{\ln\left(\frac{4D}{d} - 1\right)}$$

Two $$q_2 = \frac{2\pi k(T_G - T_C)}{\ln\left(\frac{4D}{d} - 1\right) + {}^1/_2 \ln\left(\frac{4D^2 - 2Dd}{Z^2 + d^2/4} + 1\right)}$$

Nomenclature:

D = depth, ft
k = thermal conductivity, Btu/hr ft deg F
q_1, q_2 = heat absorbed per foot of tube, Btu/hr ft
d = tube diameter, ft
T_G = surface temperature of earth, deg F
T_C = surface temperature of buried tube, deg F
Z = horizontal distance between tubes, ft
ln = logarithm to the base e

negligible after 800 hr of steady operation. Remember, however, that freezing a moist soil appreciably increases the thermal conductivity in the frozen zone.

Small tubes are preferable to large ones with the optimum somewhere between $^1/_2$ and $^3/_4$ in. diam. Several tubes spaced about 3 ft apart horizontally should be used in the same trench for the most economical arrangement.

It should be possible to design a heat-absorbing ground-coil system from the data here presented, once the properties of the local soil are known.

ACKNOWLEDGMENT

The experimental work reported in this paper was conducted at the University of Connecticut. The project was sponsored by the Connecticut Light and Power Company with the active co-operation of the American Brass Company, and the financial assistance of both the Connecticut Power Company and the Hartford Electric Light Company.

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BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

COMPILED AND EDITED BY J. J. JAKLITSCH, JR.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Engineering-College Enrollment

THE highest undergraduate enrollment, 51,107 students, in engineering colleges throughout the United States and Canada was in the mechanical-engineering curriculum last year, according to the annual report on enrollment in engineering colleges published in the February, 1949, issue of *The Journal of Engineering Education*.

Allied fields, such as aeronatuical-engineering and industrial-engineering curriculums, had enrollments of 6853 and 8590 students, respectively.

A total of 226,117 undergraduate engineering students were enrolled in the 151 colleges reporting in October, 1948, as compared with 230,180 students in 149 colleges reporting in October, 1947. This represents an increase of 108 per cent above prewar 1940 engineering enrollment. The report states that the engineering enrollment in 1948 constitutes 10 per cent of the total college enrollment of 2,410,000 as reported by the U. S. Office of Education.

Distributions among the other three principal curriculums were as follows: electrical engineering, 49,907; civil engineering, 31,798; and chemical engineering, 21,248. Together the four curriculums compose 63 per cent of the total undergraduate enrollment.

Approximately 64 per cent of all undergraduates are veterans. The highest percentage occurs in the senior year, where 83 per cent of the students are veterans.

Enrollment in the 1948 freshman class declined to 85 per cent of last year's class, but still is 48 per cent higher than the 1940 freshman class. It is not possible to compute the attrition rate for various classes from the enrollment statistics, the report points out, since there appeared to be a large influx of new students into all classes during the year. For example, the present sophomore class is 7.9 per cent smaller than last year's freshman class, the junior class is 16.2 per cent smaller than last year's sophomore class, and the senior class is 5.3 per cent smaller than the previous junior class. The usual attrition rate is considerably greater than this, as evidenced by the fact that only 40 to 45 per cent of all entering freshmen eventually graduate.

Of a total of 30,018 first degrees in engineering granted during the year, 8294 were in mechanical engineering, 1340 in aeronautical engineering, and 2492 in industrial engineering. Chemicals, civils, and electricals granted 3353, 3271, and 6555 first degrees, respectively.

The graduate enrollment shows a slight increase of about 6.5 per cent at the master's degree level but a more pronounced increase of 24.3 per cent at the doctorate level, as compared with last year's figures. The 4356 master's degrees awarded during the 1947–1948 school year represent a 40 per cent increase over the preceding year, while the 254 doctorate degrees represent a 98 per cent increase. On the master's degree level, all four principal curriculums, i.e., chemical, civil, electrical, and mechanical engineering have approximately equal enrollments (the mechanicals have 2533 enrolled), but on the doctorate level, chemical and electrical engineering are predominant, each having more than double the enrollment of either civil (218) or mechanical engineering (202).

Coal-to-Oil Plants

TWO synthetic-fuel plants were dedicated by the U. S. Bureau of Mines at Louisiana, Mo., last month. The plants will demonstrate the respective merits of two basic processes, direct hydrogenation and the Fischer-Tropsch synthesis, for converting American coals to oil. The processes are complementary rather than competitive and their products range from heavy fuel oil and waxes to jet fuels and aviation gasoline.

The coal-hydrogenation plant is complete, it has been tested, break-in runs have been carried out, and the plant is ready for production. It was built at a cost of $10,000,000 under a contract awarded to Bechtel Corporation of California in May, 1946. An article by J. A. Markovits, assistant chief, Coal-to-Oil Demonstration Branch, Office of Synthetic Liquid Fuels, Louisiana, Mo., summarizing the process and describing the special equipment used in the coal-hydrogenation plant, will be published in a forthcoming issue of MECHANICAL ENGINEERING.

Now under construction, the gas-synthesis demonstration plant is scheduled for completion this year. A contract for its

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources, i.e.: (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

design and construction was awarded to Koppers Company, Inc., of Pittsburgh, Pa., in March, 1948, at an estimated cost of $5,000,000. The coal-gasification section of the plant was tested and is ready for operation.

This plant is designed to perform two principal operations. It will convert coal to a mixture of gases and these, in turn, to gasoline and oils. Actually, the chain of process steps necessary for the over-all transformation is not simple. These steps consist of (1) production of oxygen, (2) gasification of coal using oxygen and steam, (3) purification of the gas, (4) catalytic conversion of the gas to gasoline and oils, and (5) separating and refining the products.

This series of units, constituting the over-all Gas Synthesis Demonstration Plant, is of a size to convert coal to 80 bbl per day of synthetic liquid fuels. Some of the basic processes, such as the gasification technique and the basic Fischer-Tropsch operation, originated in Germany and have been further developed in this country. Promising advances made in the Bureau of Mines broad research and development program on these phases of the work are being incorporated in the new plants.

The demonstration plant includes a Linde-Frankl oxygen unit of German origin. This unit was operated for several years in Germany and, at the end of World War II, was dismantled, brought to this country, reconditioned, and erected at Louisiana, Mo. The plant has been in operation for short periods of time in this new service and has produced up to 24 tons per day of 98 per cent pure oxygen.

The coal-handling facilities are intended to dry run-of-mine coal and reduce it to approximately 200-mesh, after which it is conveyed pneumatically and stored in bulk hoppers, from which it is fed to the gasifier system. The crushing, drying, and grinding rate will be several times the gasifier requirements, so that this can be operated on the day shift only.

Coal gasification at Louisiana will be accomplished in a pulverized-coal-type gasifier, into which the coal is injected as a suspension in oxygen and superheated steam. The steam used is superheated to 2500 F in a pebble heater. The pebble heater is a newly developed apparatus in which pebbles are heated and circulated and give up their heat by contact with the steam being superheated. The gasifier vessel proper is a refractory-brick-lined, horizontal steel cylinder. Into each end of the cylinder a flame, constituting partial combustion products of coal, oxygen, and steam, burns, maintaining an internal temperature of 2500 F or above. The unit will require about 28 tons of coal, 24 tons of oxygen, and 35 tons of superheated steam per day to produce more than 2 million cu ft per day of raw synthesis gas. This gas will consist principally of a mixture of hydrogen and carbon monoxide, which are the active ingredients for direct conversion into gasoline, accomplished in subsequent operations.

The gasification unit was sized on the basis of the oxygen plant available. To augment the supply of synthesis gas and to provide an effective means of making any desired adjustments in the synthesis-gas composition, there are provisions for adding up to 50,000 cu ft per hr of gas from an existing catalytic natural-gas reformer at the Missouri Ordnance Works plant.

Gas produced in the gasifier will be cooled and the fine particles of dust and ash removed. At this point the heat content of the gases is recovered in a waste-heat boiler and about 4000 lb per hr of high-pressure steam is generated. After compression to 300 to 400 psi, the gas will be treated for removal of sulphur compounds and gum formers. The hydrogen sulphide concentration will be reduced to about 10 grains per 100 cu ft

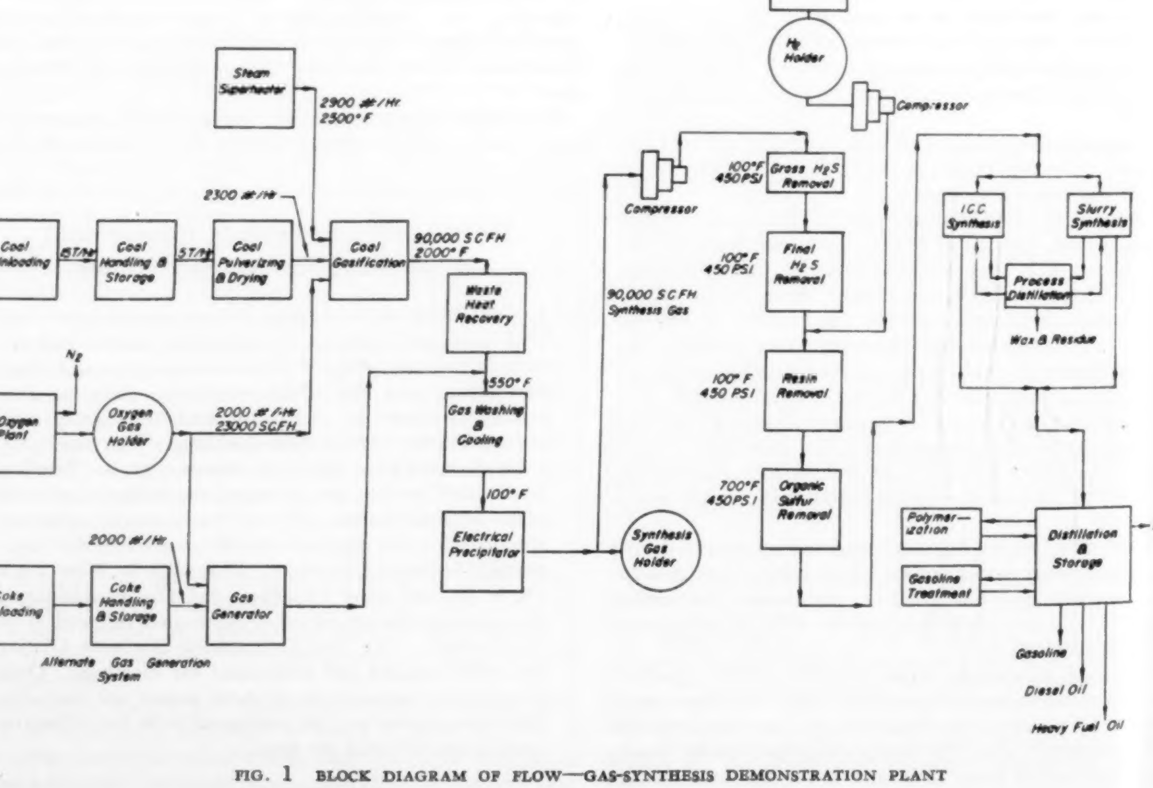

FIG. 1 BLOCK DIAGRAM OF FLOW—GAS-SYNTHESIS DEMONSTRATION PLANT

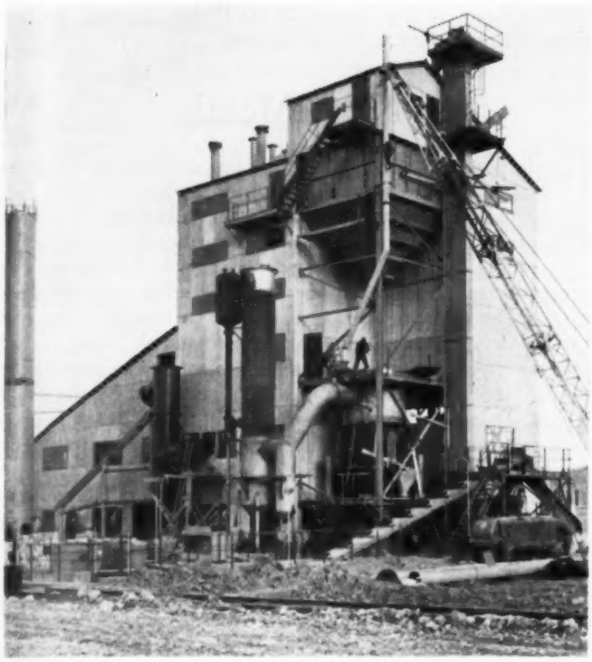

Fig. 2 SHOWN UNDER CONSTRUCTION, THIS COAL-GASIFICATION UNIT WILL SUPPLY CARBON MONOXIDE AND HYDROGEN TO THE GAS-SYNTHESIS DEMONSTRATION PLANT

by scrubbing with triethanolamine solution. The scrubbed gas will then be further purified by treatment in two iron-oxide towers in series, followed by treatment with activated charcoal. Finally, after passing through a bed of alkalized iron oxide heated to 600 F, for removal of final traces of organic sulphur compounds, the gas is ready for conversion to gasoline. Thorough purification by treatment in each of these steps is critical. Failure to completely clean the gas would result in mechanical contamination of the synthesis catalyst or in rendering it inactive through poisoning by sulphur compounds remaining in the gas.

The gas-synthesis process to be used is a version of the original Fischer-Tropsch reaction. American research has modified German adaptations and streamlined the process to a point where it appears that the developed processes will have some chance of competing economically in the future. There are several approaches to gas synthesis. The Bureau of Mines engineers choose to demonstrate two methods. In the first of these the purified gas is bubbled through a reactor filled with a fixed bed of a granular catalyst which is submerged in a circulating cooling oil. The reactor, about 6 ft in diam and 25 ft deep, will hold about 40 tons of catalyst. By contact with the catalyst, the gas is changed into hydrocarbon products such as gasoline, oils, and liquefied petroleum gas.

The second type of reactor (nominally 40 bbl per day capacity) will contain a finely divided catalyst suspended in circulating cooling oil through which the gas will pass. Circulation is expected to be carried on at an extremely high rate—about 3000 gpm—to maintain the catalyst in suspension and allow a high rate of heat transfer to the steam-generating tubes.

Both systems require an elevated temperature, 500 F, and pressures in the neighborhood of 400 psi to make them effective.

It is anticipated that the plant will produce daily about 55 bbl of finished gasoline, 10 bbl of Diesel oil, 12 bbl of heavy oil and waxes, and 5 to 10 bbl of propane. Separation of these products by distillation follows quite closely the conventional methods of petroleum-refinery practice.

The distillation section is designed to perform three important functions: The wax formed in the reactions must be removed from the cooling oil to avoid accumulations that might unfavorably affect the catalyst, the light products and distillate fuels must be separated and recovered, and the cooling oil must be separated and the proper amount returned to the synthesis section.

Gasoline is reported to be of high quality. After upgrading, by means of the special high-temperature catalytic treatment provided in the demonstration plant, and by addition of tetraethyl-lead, a motor fuel of 80–85 octane number (motor method) is produced. The process is also capable of yielding a superior Diesel fuel. A by-product of the reaction is a mixture of organic chemicals, obtained in a water solution. This can be concentrated and obtained in fairly pure form for marketing. There will be no provision in the demonstration plant for this recovery. However, samples will be laboratory tested and evaluated. Through cracking, the waxes can be converted to Diesel fuel and lubricant.

The plants involved in the Gas Synthesis Demonstration Plant are being built progressively. As they are completed, steps are taken without delay to put them into operation. The oxygen plant has been under intermittent operation since January, 1949. The gasifier plant was scheduled for operation during this spring. The purification section is under construction and the bulk of the engineering of the synthesis and distillation units is finished. It is anticipated that the entire plant will be completed and ready to operate within the year.

Aluminum Welding

NEW developments in synthetic-gasoline manufacture and in the design of oxygen-manufacturing equipment to be operated as a part of the synthetic-fuel process brought about the need for more extensive research on the welding of aluminum plating for thick-walled pressure vessels, heat exchangers, and similar equipment. At Battelle Memorial Institute, research on this general problem began in 1946 with an investigation for the Army Ordnance Department on the welding of aluminum-alloy plates in thicknesses of one inch and over, which is still in progress. As a consequence of the new synthetic-gas and oxygen developments two additional projects on aluminum welding were begun at Battelle: one for the Stacey Brothers Gas Construction Company, on welding techniques and the properties of welded joints in thick aluminum plates; and the other for the Air Reduction Sales Company, on the development of new welding processes for thick aluminum plating. See frontispiece on page 462 of this issue.

A paper "The Strength of Welded Joints in Thick Aluminum Plates," by C. B. Voldrich, Battelle Memorial Institute, Columbus, Ohio, dealing with the results of some of the work conducted on the three projects, chiefly that concerning the strength properties of welds in thick plates, was presented at the 1948 ASME Petroleum Division Conference, held in Amarillo, Texas.

The base materials used in the welding tests were $1^1/_2$-in. rolled plates of the strain-hardening alloy 3S and the heat-treatable alloys 24S, 61S, and 75S.

The researches conducted at Battelle demonstrate the practicability of welding thick aluminum plates into useful engineering structures. The tests show that for the aluminum alloy 3S, welding methods and filler metals are now available which will produce weld joints with strength and ductility approach-

ing those of the base metal; and furthermore, that these strength properties do not change, but even improve, at the low temperatures which obtain in the operation of equipment such as that for oxygen manufacture.

The results of the investigations also show that at least some of the heat-treatable aluminum alloys can now be welded in thick sections, with weld-joint strengths far greater than those obtainable with the common alloys, 2S and 3S. However, with the techniques and filler metals now available, the welding of the heat-treatable alloys is still attended to an undesirable degree by the hazard of weld-metal or parent-metal cracking during welding. Except at the lower strength levels, the ductility of the welds is quite low for most engineering applications. There is also the problem of the influence of the welding heat on the properties of the parent plate, which will become more important as the strength properties of the weld metal are improved.

The indications, at least for the time being, are that weldments made of thick plates of the high-strength aluminum alloys are practicable if the design is based on "as-welded" strength properties. There are several reasons for this limitation. First, the filler metals now recommended (43S, and possibly 716) produce welds which do not increase in strength if aged after welding. Consequently there is not much advantage in aging the weldment, except in certain alloys, to obtain an improvement in corrosion characteristics. Second, full heat-treatment does not improve the strength properties of the weld metals; it increases only the yield and tensile strengths, with the ductility remaining at an undesirably low level. Therefore the efficiency of the welded joints in a structure is not usefully improved by subjecting the structure to a full heat-treatment after welding. Third, the solution heat-treatment and quenching of aluminum-alloy weldments, especially large and complex ones, is a difficult and delicate procedure, because aluminum has very low strength at the temperatures required for solution treatment, and because it is necessary to maintain very good control of the temperatures, furnace atmospheres, and quenching rates.

Research on the foregoing and related problems is proceeding on an increasing scale in many fabrication plants and laboratories. There are promising developments in new filler-metal compositions, the report states. The low-temperature strength of welded joints in the heat-treatable alloys is being determined. Equipment for aluminum welding, including torches, transformers, and auxiliary apparatus, is being improved. Methods for mechanizing the argon-arc welding process, such as those which have been so successful in thin-gage applications, are being investigated for the welding of thick aluminum plates.

New and different methods of welding aluminum are being studied and applied. These range from welding at room temperature (no heat applied to the work), flash welding, and submerged-melt welding to methods in which arc welding is done with bare aluminum electrodes in shielding atmospheres. Research on the last-named process, at the Airco Research Laboratories and at Battelle, is in advanced stages. This process shows great promise for many applications since it involves no chemical fluxing, and makes possible manual welding in all positions, and automatic welding at rates considerably greater than those obtainable with the methods now commonly used.

The results of this widespread research have already been applied in the fabrication of many large aluminum weldments, and there are encouraging indications that at least some of the more exacting desires of design engineers and fabricators will ultimately be realized.

The complete paper appears in the June, 1949, issue of the Welding Research Supplement of *The Welding Journal*, publication of The American Welding Society.

New Metals

BY developing still better refining processes, an article in the March, 1949, ***Industrial Bulletin*** of Arthur D. Little, Inc. points out, such metals as molybdenum, titanium, zirconium and tantalum should offer more and more uses to engineers.

According to the ***Bulletin***, molybdenum is finding use as a structural metal, now that new manufacturing techniques permit a wider range of sizes and shapes. Although it has been known for years as an alloying constituent of "moly steels," and as supporting wire for tungsten filaments in incandescent lamps, large molybdenum parts were restricted by the size of ingots. A new process makes ingots up to 450 lb available, as well as large tubes and cylinders, and new uses are under development.

Because of its high melting point, about 4750 F, and its affinity for oxygen, ordinary methods of melting and casting are not possible. One method used is to form bars from molybdenum powder, under high pressure, and then to "sinter" or partially fuse the bars by passing a powerful electric current through them, in an atmosphere of hydrogen. The bars are rolled or forged, then worked to sheets, plates, or wire. The latest process for producing ingots involves melting and casting the metal under vacuum, with heat from an electric arc.

The primary demand for molybdenum has been in the electronic industry, but it has also been used for electrodes in electric glassmaking furnaces, and as an electric heating element in furnaces where oxygen is excluded. Use in dies for die-casting high-melting alloys, such as brass, is being investigated, and experimental parts for the aircraft and petroleum industries have been produced.

While molybdenum is not as abundant as aluminum, there are substantial deposits in the United States, which supply about 90 per cent of world requirements. The metal in powder form sells for about $3 a pound. As improved manufacturing techniques and greater demand appear, the price may be further reduced.

Titanium is potentially a large-scale structural metal. About one and a half times heavier than aluminum, with corrosion properties and strength equivalent to common stainless steel, titanium fills the gap between the light metals and the ferrous alloys. The large deposits of titanium ore have been mined for years to supply white titanium dioxide pigment to the paint industry, and about a ton or so of the metal is being consumed monthly for experimental work. As yet, however, there is no industrial application of titanium metal.

Reduction to pure metal is involved and expensive, since titanium is highly reactive at elevated temperatures. The metal must be purified and melted in a vacuum or inert atmosphere, or compacted by pressing and sintering. At the present price of $5 a pound for sponge metal produced in a pilot unit, use is limited to specialty applications and as an alloying element. If process improvements are made and prices go down, titanium may sometime become competitive with stainless steel.

Zirconium, the sister metal of titanium, is resistant to corrosion by many acids. In applications where this is an asset, zirconium may in time supplant tantalum, which is less plentiful and two and a half times heavier. Although most of the zirconium minerals used in this country are imported, there are substantial domestic deposits, which may tend to lower the price when an economical recovery process is developed.

Because zirconium is even more reactive than titanium

greater care must be taken to exclude air and moisture during reduction. The preparation and properties of pure zirconium are being studied at the Bureau of Mines. It has recently been reported that the metal may have possibilities as a structural material in atomic power plants.

Tantalum is not plentiful enough for large-scale use (peak wartime production was just over fifty tons a year), but the metal has interesting possibilities. It is heavy and inert, totally unaffected by most acids, and this resistance to corrosion has made it useful in acid plants. First produced commercially in 1922, it was used in rectifier cells for the early battery-operated radio sets. Now its high melting point, 5200 F, makes it especially useful in the manufacture of high-vacuum radio tubes, where its low volatility at high temperatures and ability to absorb gases when heated are also assets.

Tantalum has been used extensively in surgery, since it is not attacked by body fluids. Portions of bone have been replaced with tantalum, and braided tantalum sutures are particularly useful in plastic surgery. A recent development is a tantalum liner for the back of glass eyes, to reduce irritation of membranes of the eye sockets.

The high price of tantalum in powder form, $38 a pound, reflects the cost of the ore, $6000 a ton, which is scarce and dispersed through Africa, Australia, South America, and the United States. Each ton of ore requires the removal of 3000 tons of rock. Although use will be restricted to special applications, expansion of the electronics industry may make tantalum a familiar metal.

Rubber-Tired Train

A RAILWAY coach using pneumatic rubber tires is described in *Rubber Developments*, March, 1949. The "silent train" is running on the Paris-Strasbourg express route.

The article points out that the idea of the rail tire goes back to 1929, when experiments carried out by the Michelin Company led to the "Micheline" rail coach, which one may regard as the forerunner of the train on pneumatic tires and as a necessary intermediate stage.

From the rail car to the rubber-tired train, it would seem, was but one step, but it involved many problems, including the design of a bogie which would enable speed to be maintained in case of a burst to the next stopping place, even though this might be 100 km or more away. The investigations begun in 1939 were continued during the occupation, trials having been carried out in North Africa since 1942. The reason for using tires is as follows: The rail tire, by its own resiliency, partly takes up differences in track level, the axles being fixed and the wheels turning on the axles through roller bearings. The five axles are linked to the bogie chassis by elastic devices known as "Bibaxes." The Bibax consists essentially of a block of rubber of precisely controlled elasticity. The bogie thus possesses the necessary flexibility to enable it to hold the track perfectly.

The coachwork suspension on the bogie is by two transverse springs sliding on runners arranged on cross-members and two longitudinal springs to which the body is connected by links. The bogie chassis, the axles, and the wheels thus form a sufficiently rigid unit to insure that in the event of a tire becoming deflated at an awkward moment, the over-all load is spread over the other nine wheels. From that moment the damaged tire no longer carries any load and consequently can travel without harm.

Each carriage is mounted on two bogies, i.e., 20 wheels. Since the pneumatic tire calls for lightweight construction, the technicians had a new problem to solve, that of lightness, though the conception of safety was not to be lost sight of on that account. Thus the stainless-steel train produced by Ets. Carel Fouché has been considerably lightened (16 tons per coach), if compared with the latest production of the French State Railways. The coaches in the train are naturally not so robust as the lighter coaches of the French State Railways, but, nevertheless, because of stainless steel, they offer a satisfactory guarantee of safety.

The coaches are linked by a central coupling of the semiautomatic type in which rubber is used to a large extent, and which is of low flexibility under tension.

In the event of collision, protection for passengers is afforded by a combination of devices, the object of which is to absorb a large number of foot-pounds with considerable displacement from the point of application of the forces. Under compression, the couplings are of high elasticity, which is obtained from a battery of Bibaxes fitted in series, and at the end of the coaches there are special pneumatic shock absorbers, fitted to the end wall. These shock absorbers are of sufficient diameter to come into contact even in cases where coaches are greatly distorted. If distortion is too extensive for contact to be assured, their resilient surface cannot pierce the walls of the other coaches. The bursting of this antishock pneumatic device dissipates some 14,600 ft-lb derived from the energy of shock before permanent deformation of the framework.

The braking system adopted is the oleopneumatic system. Each bogie is served by a special oil circulation terminating at a Lockheed master cylinder, coupled to a compressed-air receiver with diaphragm. The bogie wheels are all braked by brake drums of large dimensions following the lines adopted on automobiles.

The train on pneumatic tires derives many of its qualities from rubber, which is used not only in the wheel fittings but also in the suspension and the antishock devices, not to mention the part it plays in the interior furnishing of the coaches.

Low CG Train

A NEW train, said to be the first ever built in America based on the Spanish "Patentes Talgo," has been completed by the American Car and Foundry Company for testing and demonstration in America. Designed by ACF and Talgo engineers and constructed at the Berwick, Pennsylvania, and Wilmington, Delaware, shops, this new streamliner is the first of three such trains. The other two are destined for revenue service in Spain between Madrid and the French border, a distance of approximately 500 miles, and will connect with de luxe express-train service to and from Paris.

A comparison with streamline equipment on the railroads today shows the "ACF-Talgo" to have floors 2 ft 9 in. lower, a weight reduction of nearly 75 per cent due to both its design and all-aluminum construction, and an over-all height lower by almost 4 ft. It has an extremely low center of gravity.

Each train for Spain will consist of a Diesel-electric locomotive, a baggage unit, and three coaches, the last of which features an observation lounge. The over-all length of the train is approximately 370 ft and is for 5 ft 6 in. gage track. The coaches consist of four articulated passenger units and one equipment unit, each of which has only one pair of wheels in the rear. The front is supported by a special coupling arrangement on the unit ahead of it, while the first unit is supported by the locomotive which is on conventional-type trucks. Entrance to the coaches is gained through the equipment unit which is in the center of each coach. These equipment units contain various facilities such as air-conditioning, control lockers, washrooms, and kitchenettes for serving light meals.

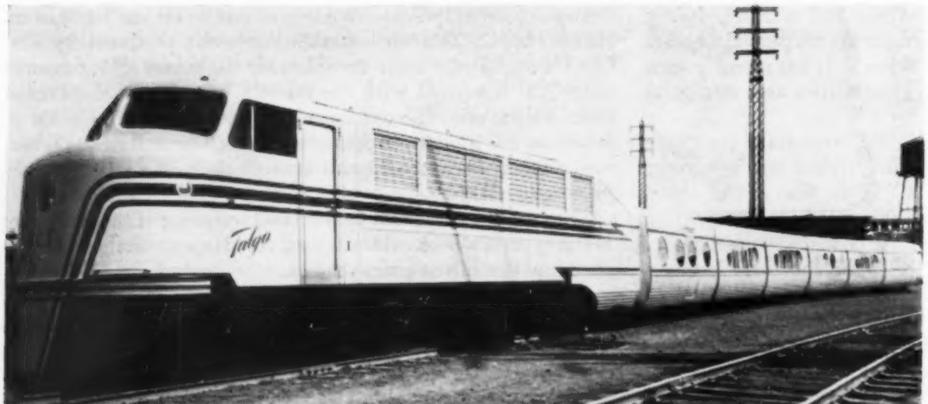

FIG. 3 NEW ACF-TALGO TRAIN DESIGN FEATURES A LOCOMOTIVE TWO FEET LOWER THAN A STANDARD DIESEL-ELECTRIC AND COACHES FOUR FEET LOWER THAN PRESENT-DAY EQUIPMENT, WITHOUT LOSS OF INTERIOR SPACE

Each coach is 100 ft long and seats 64 passengers, 16 in each passenger unit, with the exception of the coach containing the observation-lounge unit which is seven feet longer. The entire train seats 176 passengers with 16 additional seats in the lounge.

An experimental train of this type has undergone successful tests in Spain.

The train which has been completed for experimental purposes in the U. S. is of identical design to the trains destined for Spain with the exception of length and gage which is generally 4 ft $8^1/_2$ in. in the Western hemisphere. The American experimental and demonstration train consists at this time of only a Diesel-electric locomotive, a baggage unit, and a coach of five units, one of them being for equipment and another serving as an observation lounge. The train is 168 ft long and only approximately one third of its eventual length.

Some of the ideas which have been incorporated into the train are wide-vision windows, 42-in. seat spacing, wardrobes and luggage storage facilities in each coach, individual ash trays at each seat, kitchenettes to provide meal service at seats, and an observation end from which passengers have extra-wide visibility. It is stated that the train can be adapted to both long and short hauls, coach or sleeper service depending on the requirements of individual railroads, and its passenger carrying capacity increased or decreased to suit the density of traffic.

Reheat Cycle

THE past, present, and future of the steam-turbine reheat cycle is discussed by C. A. Robertson, Mem. ASME, engineer in charge, Test and Engineering Calculations Groups, Steam Turbine Department, Allis-Chalmers Manufacturing Company, in the Allis-Chalmers *Electrical Review*, first quarter, 1949.

Today, writes Mr. Robertson, reheat cycle means that high-pressure, high-temperature steam, after partial expansion in the turbine, is extracted at low or intermediate pressure, re-superheated in the boiler, and returned to continue its flow through the turbine. An increase of 4 to 6 per cent more of the total heat energy generated by the boiler is thus converted to useful work by the turbine than would be possible without reheat.

Because of its more efficient fuel and steam utilization, the reheat cycle has been applied in approximately 20 utility stations in the United States since the first installation in 1924.

Experience with 65,000, 80,000, and 115,000-kw tandem-compound units installed in the last 18 years indicates not only an increase in thermal efficiency, but also an equal flexibility in performance of the reheat units as compared to the nonreheat turbines, he states. Operating records of these regenerative reheat steam turbines have included base load and varying load operation, with frequent start-up and shutdown performance. Protective equipment in the reheat line has functioned reliably and modifications for succeeding designs relate primarily to details. The number of large new reheat units now under construction for high-economy stations indicates that the reheat cycle is now being accepted as readily as the regenerative cycle was 25 years ago. (A forthcoming issue of Trans. ASME will feature the seven papers and discussion on modern reheat turbines which were presented at the 1948 ASME Annual Meeting in New York, N. Y.)

Mr. Robertson pointed out that thermodynamic advantages of reheating steam were recognized and have been applied since the early days of the steam engine. The first patent describing a method of steam-jacketing cylinder walls to prevent condensation on inner cylinder walls was obtained by James Watt in 1769. Perhaps the first to use reheating by means of live-steam coils in the receivers of compound engines was John Bourne. His application dates back to 1859.

By the turn of the century many compound engines, principally pumping engines, were equipped with reheaters. Published tests even describe the performance of an air compressor with four steam cylinders having three stages of reheating as well as four stages of regenerative feedwater heating. It appears that up to this time reheating was achieved by live steam.

In 1891 Parsons devised and patented a process of interstage live-steam reheating in steam turbines by means of cored spaces in the diaphragms of a radial-flow turbine. By 1900 a 1000-kw Parsons tandem-compound turbine was tested experimentally with externally fired reheat between cylinders. A 3000-kw Parsons cross-compound geared turbine generator unit employing both reheating and regenerative feedwater heating was built in 1916, with reheating achieved by a waste-heat reheat boiler. Occasional development and application of reheating was conducted by European engineers up to the early 1920's; however, only a small amount of performance information was published.

From the start, most of the attention was directed toward the raising of steam pressures and temperatures. This introduced new problems, one of which related to metallurgy.

About the time of World War I, steam temperatures had risen to the extent that excessive growth of cast-iron cylinders occurred. Up to this time, cast iron was the chief ferrous material used for turbine castings.

Carbon-steel castings replaced cast iron in high-temperature parts, making possible the advancement of steam temperatures

from 550 F to approximately 700 F by the early twenties. Steam pressures during this period were of the order of 200 to 250 psig.

Boiler design for high temperatures, especially superheaters, offered more difficulties than steam-turbine design. The latter therefore kept pace with developments in steam generation.

Metallurgical knowledge of materials used in both boilers and turbines in the early twenties restricted steam temperatures to 700 or 750 F. Consequently, increasing steam pressure was the only alternative if economy was to be improved further.

Analyses were made at this time to determine the possibility of raising steam pressures. The results indicated a maximum of 350 to 400 psig for 700 to 750 F steam temperatures without increasing the moisture content at the exhaust above the accepted safe value of 10 to 12 per cent. Moisture at the exhaust causes erosion of low-pressure exhaust blading together with loss of efficiency. The degree of erosion is somewhat proportional to the amount of moisture, an effect which increases with blade speed.

Reheat appeared to be the logical solution with steam temperatures limited to 700 to 750 F range because it improved economy by increasing available energy; increased the enthalpy at exhaust, resulting in lower moisture; and reduced moisture at exhaust, resulting in fewer stages operating in the wet field and with less moisture.

First large-scale regenerative reheat turbines of 40,000 and 60,000 kw for steam at 600 psig and 725 F were installed in 1924. These turbines were, respectively, single-cylinder with reheat between stages and cross-compound with reheat between cylinders. Both installations employed separate reheat boilers. The first was in the Philo station of Ohio Power Company, the latter was in the Crawford Avenue station of the Commonwealth Edison Company.

High-pressure reheat installations of the 1300-psig type were first put into service in 1925 and 1926. The first of these was accomplished by adding a 3360-kw topping unit at the Edgar station of the Boston Edison Company, and the second was the first of four 7700-kw topping turbines at Lakeside station of the Wisconsin Electric Power Company.

Exhaust steam in these installations was resuperheated in the reheater, an integral part of the high-pressure boiler, for further expansion in low-pressure units. Approximately six stations in the United States are using topping reheat turbines at the present time, with twelve turbine-generator units involved.

Cross- and tandem-compound turbines of both 600 and 1300-psig classes were in operation, or being installed in 1930. These utilized boiler reheat, steam reheat, or a combination of both.

Judged by present-day standards, Mr. Robertson points out that the most important reheating development relates to the two general types of turbines presently under construction: tandem-compound turbines with reheating between stages in the high-pressure cylinder, and cross-compound-type units with reheat between cylinders.

The early tandem-compound turbines with reheating between stages in the high-pressure cylinder were the 65,000-kw and 115,000-kw turbine generator units for the Public Service Company of Northern Illinois, at Waukegan, installed in 1930 and 1931, respectively. Steam flow was unidirectional through the high-pressure cylinder.

About 29 reheat steam turbine-generator units of various condensing types were installed between 1924 and 1932. Twenty of these were of the 600-psig, 725-F class, and nine were of the 1300-psig, 725-F category.

The first 825-F reheat steam turbine-generator unit was installed in 1935 at the Port Washington station of the Wisconsin Electric Power Company. It was an 80,000-kw unit and now operates with steam conditions of 1230 psig, 850 F, reheat to 850 F, and $29^1/_2$ in. referred vacuum. This tandem-compound turbine, with reheat between stages in the high-pressure cylinder, was the first installation to use the now accepted one boiler per turbine arrangement in which the reheater is an integral part of the boiler, simplifying reheat temperature control.

Only three reheat turbine-generator units were installed in the United States from 1932 to 1941. These were Port Washington No. 1, 80,000 kw; State Line No. 2, 150,000 kw; and Powerton No. 4, 105,000 kw.

Advancement of metallurgical knowledge and experience in the 1930's permitted increases in initial steam temperature through the use of alloy steels and allowed raises in steam pressure to 1300 psig without exceeding recognized limits of moisture at the exhaust. This accomplished one of the factors which led to reheating and resulted in the installation of a large number of nonreheat plants. Use of nonreheat topping turbines in the late thirties, although limited in application, provided gains in station economy.

Opinion was divided between the use of a simple plant without reheat or the continuation of reheat with its highest thermal efficiency and cost, Mr. Robertson stated. However, with the rising cost of fuel, and in spite of the advent of still higher pressures and temperatures, the reheat cycle is again gaining favor.

Another noteworthy development of reheat turbines cited by Mr. Robertson, has been their successful application for ship-propulsion service as well as for central-station service.

Since 1941 reheating has returned for a large number of units for initial temperatures of 900 to 1050 F with initial

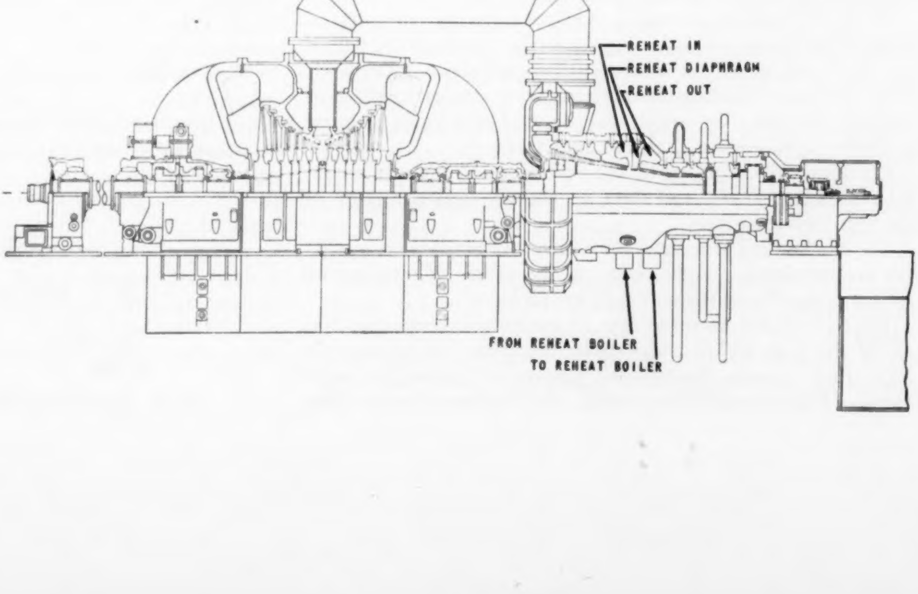

FIG. 4 INTERSTAGE REHEAT DESIGN USED IN CONSTRUCTION OF 80,000-KW REHEAT UNIT RECENTLY INSTALLED BY A LARGE MIDWEST UTILITY SHOWS THE UNIDIRECTIONAL FLOW OF STEAM THROUGH THE HIGH-PRESSURE CYLINDER

pressures from 1380 to 2300 psig. These represent the present-day renewal of interest in the reheat cycle because of the improvement in plant economy and increasing fuel costs.

The trend toward reheat today involves tandem-compound units from 40,000 to 100,000 kw, with reheating between stages of the high-pressure cylinder and cross-compound types of the order of 125,000 to 150,000 kw.

A further step in the direction of higher economy, where condensing cooling-water temperature permits, may be to use vacuum lower than one inch absolute, it was revealed. Reheat will serve a very useful purpose from such installations by reducing the potentially higher than usual moisture at the exhaust.

Nickel and Nickel Alloys

AN up-to-date revision of the paper "Nickel and Nickel-Base Alloys—Their Use in the Design of Corrosion-Resistant Machinery and Equipment," by F. L. La Que, originally published in MECHANICAL ENGINEERING, December, 1936, pages 827 to 843, has been issued as Technical Bulletin T-13 by the Development and Research Division, The International Nickel Company, Inc., New York 5, N. Y. The bulletin can be obtained without cost by writing to the company.

Discussed in the revised version of the paper are the following materials: (1) Nickel, commercially pure wrought nickel; (2) L nickel, a low-carbon nickel; (3) Z nickel, a nickel hardenable by heat-treatment; (4) monel; (5) K monel, a monel hardenable by heat-treatment; (6) R monel, a free machining monel; (7) KR monel, a free-machining monel hardenable by heat-treatment; (8) H monel, a cast monel of higher hardness; (9) S monel, a cast monel hardenable by heat-treatment; (10) Inconel; (11) Inconel X an Inconel hardenable by heat-treatment; (12) the Hastelloy alloys, A, B, C, and D; and (13) illium.

In addition to these materials which are discussed in some detail, attention is directed to a corrosion-resistant, hard-surfacing material known as Colmonoy, the No. 6 grade of which has a nickel base (about 75 per cent nickel). Another essential constituent is chromium boride. This material produces deposits having a hardness of 58 to 60 Rockwell C (545 to 575 Brinell), and the deposits are resistant to mineral and organic acids and to alkalies. The coating material may be deposited by oxyacetylene or metallic-arc welding, or may be cast on by pouring the molten alloy at from 2350 to 2500 F into a suitable mold containing the base metal preheated to from 1200 to 1400 F. Colmonoy No. 6 is used for pump sleeves, pump rods, cam collars, etc., and for plug cocks to counteract galling or seizing tendencies.

There are available a number of alloys containing from 60 to 80 per cent chromium, with the remainder mostly iron, which are used principally for heat-resisting purposes. In general, their corrosion-resisting characteristics are similar to those of Inconel, the notes on which may be used as a guide to their probable usefulness in chemical equipment.

Chemical compositions of the several materials under consideration are shown and data on the physical constants of the materials are given.

The mechanical properties for which reliable data are available are tabulated. Some data on the effects of temperature on the properties of the materials are included.

It will be noted from the data on mechanical properties that all of the high-nickel alloys under discussion are strong. In fact, they possess mechanical properties comparable with those of high-strength alloy steels. It is noteworthy also, that these high-nickel alloys retain their strength, ductility, and toughness over a wide range of temperature conditions. While good mechanical properties are important, the principal considerations leading to the use of these materials in industry are almost invariably based on their ability to endure when exposed to corrosive environments and to retain their mechanical properties under severe service conditions.

The limits of usefulness of a corrosion-resisting material cannot be defined as precisely as its mechanical properties, since resistance to corrosion is governed by complex factors, many of which pertain to the environment rather than to the material. These controlling factors are difficult to estimate and often impossible to control.

The bulletin is devoted to a general outline of the corrosion-resisting characteristics of each material, separately, illustrated by appropriate supporting data.

Electrolytic Tool Sharpening

A METHOD of electrolytic tool sharpening or grinding which allows shaping tools of any degree of hardness, regardless of their mechanical properties, on a grinding wheel having a considerably lower degree of hardness than the tool to be sharpened, is described in *The Engineers' Digest* (Great Britain), March, 1949. The article originally appeared in *Stanki i Instrument*, Russia, vol. 19, no. 10, October, 1948.

According to the article, the geometrical form of the tool is preserved and a good finish on the tool faces (absence of cracks and pitting) is assured. The whole process of sharpening, from the rough cut to the finishing cut, is performed on the same wheel and with the same setting.

The cost of electrolytic sharpening is considerably reduced by the possibility of substituting a copper or steel disk, easily made in any workshop, for the usual high-grade grinding wheel. This method employs direct current and a special electrolyte. The tool to be ground and the grinding wheel are connected in a direct-current circuit so that the tool forms the anode while the cathode is formed by the grinding wheel, Fig. 5. By the action of the direct current in the electrolyte, metal is continuously removed from the surface of the anode, i.e., the tool being treated.

It is stated that the inventor of the electrolytic process claims that the removal of metal proceeds both by electrochemical and mechanical action on the anode. According to the theory advanced by the inventor, the passage of a direct current through the special electrolyte used causes the formation of a film of insoluble compounds on the anode, protecting it from further electrolytic action. Removal of this protective film from the surface of the anode by the rotating grinding wheel forming the cathode exposes a fresh surface of the metal to the action of the electrolyte and thus assures the continuous removal of metal from the anode.

The efficiency and quality of electrolytic grinding depend essentially on correct selection of the electrical parameters. The higher the current intensity and voltage, i.e., the greater the quantity of electrical energy supplied to the grinding point, the greater the quantity of metal removed in unit time, and

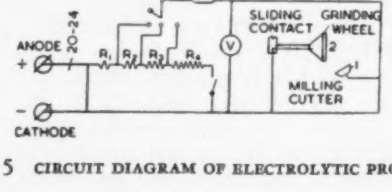

FIG. 5 CIRCUIT DIAGRAM OF ELECTROLYTIC PROCESS

consequently the greater the efficiency of the process. On the other hand, the greater the current density, the greater the roughness, i.e., the lower the quality of the resulting surface. Three stages of the process are provided for: the roughing cut, coarse grinding, and finishing. Each stage has a corresponding voltage, current intensity, and degree of finish.

The numerical values corresponding to these stages are summarized in Table 1.

TABLE 1

Stage	Tension, volts	Current, amp	Metal removed, mm/mm	Surface roughness
Roughing	18–20	40–45	0.5 –2.0	2.5 –6.5
Coarse grinding	17–19	20–30	2.3 –0.8	0.5 –2.5
Finishing	10–14	2–4	0.03–0.06	0.13–0.5

During grinding, sparking at the anode and fluctuation of the instrument needles are slight; in the finishing stage, all such external signs are practically absent.

The efficiency of the electrolytic grinding process is considerably influenced, not only by the electrical values, but also by the speed of the cathode, the pressure of the cathode on the anode, the rate of feed of the electrolyte, and the concentration of the latter.

A low speed of the cathode promotes shorting and causes roughness of the surface. With the cathode running at a very high speed, the electrolyte is forced out of the electrode gap by the centrifugal effect and electrolytic action ceases.

With increasing pressure of the cathode on the anode, the rate of removal of metal increases to a peak value, and then falls abruptly, despite further increased pressure.

To insure smooth progress without interruption, the electrolyte should be continuously fed to the grinding point in suitable quantity.

Electrolytic grinding can be performed on ordinary grinders, suitably adapted. No industrial model of a special anodic grinder has yet been developed but for introduction of the process, an adaptation of the UTZA 64 standard grinder of the "Ilyitch" Works is recommended. The following assemblies on the Ilyitch Works grinder have been redesigned:

The headstock assembly has been modified, the standard headstock being replaced by a special design, adapted for anodic grinding, Fig. 6. The grinding wheel is carried on one end of the spindle (1), the other end of which is bored to receive a spring (2). The spindle is movably keyed on a sleeve forming a pulley (3), and carries a fixed contactor ring (4), through which the current is taken from the brushes to the spindle and grinding wheel. The sleeve in which the spindle moves is mounted in ball bearings in the headstock. The grinding wheel is fed forward and pressed against the anode (the work) by means of the spring (2), and rotated by the pulley (3). The grinding wheel rotates at 1420 rpm and has a diameter of 150 mm.

A special 50-liter tank for the lubricant, piping, and nozzle have been designed for this grinder.

The entire electrical control equipment of the grinder (resistors, instruments, starters, fuses, and switches) is mounted on a separate column.

The current intensity is regulated by moving the controller from the roughing to the grinding and finishing terminals successively, thus changing the corresponding resistances.

The direct-current supply for electrolytic grinders may be taken from generators with a stable external characteristic, i.e., capable of supplying a steady voltage under variable load. The most suitable type for the purpose is a low-voltage galvanizing generator for 6–12 volts.

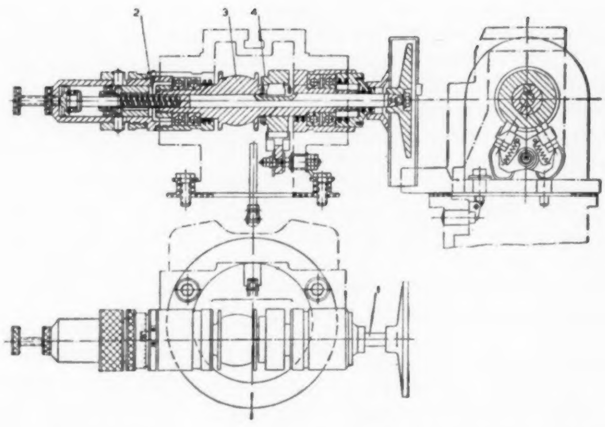

FIG. 6 REDESIGNED MACHINE FOR ELECTROLYTIC GRINDING

To obtain the voltage necessary for electrolytic grinding, the generator should be run at 1420 rpm.

In the absence of a galvanizing generator any of the following may be used:

1 *Multiple Welding Generators*. These can be most effectively used for simultaneously operating a number of grinders.

2 *Aircraft Generator Sets*. These are particularly compact and convenient for mounting on the machine.

3 *Tank Generators*, of 1000–1500 watts output.

4 *Selenium*, *copper oxide*, or *mechanical rectifiers*.

Turbo-Hearth

BASIC principles for making steel rapidly in a new vessel called a "turbo-hearth" have been announced jointly by Carnegie-Illinois Steel Corporation, United States Steel subsidiary, and Jones & Laughlin Steel Corporation, both of Pittsburgh, Pa.

The new method, it was stated, will permit the manufacture of steel of open-hearth quality, low in phosphorus and nitrogen, by directing jets of air across the surface of white-hot liquid pig iron.

The turbo-hearth attempts to combine the advantages of the basic open-hearth and acid Bessemer processes. Turbo-hearth steel is made in a partly closed, side-blown vessel, lined with refractory similar to that used in the Thomas Basic Bessemer process.

The brick lining of the vessel is magnesia rather than silica. As in the Bessemer process generally, heat is supplied by chemical reaction of the blown air with carbon and other elements of the charge. Chemical action is fast and direct, but subject to controlled conditions which reduce the nitrogen and phosphorous contents, making turbo-hearth steel comparable to open-hearth steel, hence suitable for more general use than the customary Bessemer steel.

Possible application for such a process, asserted its sponsors, would be as follows: (1) The production of low-nitrogen steel in an acid-lined vessel; (2) the utilization of conserved heat to melt larger amounts of scrap; and (3) the use of a basic lining for producing steel low in both phosphorus and nitrogen contents.

Research by Jones & Laughlin in the first two of these three phases had progressed so far that in 1942 a specially designed acid-lined, side-blown converter of $3^1/_2$ tons was installed at Aliquippa, Pa., works. Approximately 200 blows were produced and a large percentage of the ingots converted to com-

mercial products. The consistently low nitrogen content and favorable metallurgical properties of the steel were sufficiently promising to warrant construction of a full-scale converter as a next step. Accordingly, a vessel of 22 tons capacity was built. Initial trial was delayed by the war, but late in 1946 the acid-lined vessel produced a number of blows for both duplex metal and steel ingots.

Carnegie-Illinois approached the third problem—that of making low-nitrogen low-phosphorus steel of open-hearth quality from pig iron of a composition normally used in the basic open hearth. With the benefit of technical proposals of Battelle Memorial Institute, Columbus, Ohio, a co-operative project was inaugurated to develop the possibilities of this process. This was done by directing jets of air on the pig-iron bath in a basic-lined vessel.

A turbo-hearth of 1000-lb capacity was built at Battelle with special facilities for making temperature measurements and taking samples of slag, metal, and gases without interfering with operation. A sufficient number of trials were made in 1947 and 1948 to establish basic operating and metallurgical characteristics of the new process.

Operating difficulties such as are generally associated with the development of a new process have not yet been completely overcome, the sponsors said. Experience gained during this work, however, has shown to their satisfaction that the turbo-hearth process is fundamentally sound and that operating problems are not insurmountable.

Uranium Processing Plant

THE U. S. Atomic Energy Commission has signed a contract with the U. S. Vanadium Corporation for the rehabilitation and operation of the Corporation's uranium-vanadium processing plant at Uravan, Colo.

Under the terms of the contract the U. S. Vanadium Corporation has agreed to rehabilitate the plant and the company-owned townsite and install new equipment and facilities for the recovery of uranium. The Commission has agreed to purchase the mineral production of the plant at a guaranteed unit price until June 30, 1954.

The purpose of the contract is to assure operation of the plant for the period covered by the Commission's Domestic Uranium Program Circular No. 5, which became effective Feb. 1, 1949. The Circular established a guaranteed minimum price for the uranium ores of the Colorado Plateau area until 1954.

The Uravan plant is expected to be ready for operation about the end of this year. In the meantime, the U. S. Vanadium Corporation will secure ore through production from its own mines and through purchases from other producers at the prices described in Circular No. 5. Such a program provides a new market for the independent miners of the area.

Part of the ore supply for Uravan will come also from mining properties in the Calamity, Colo., area which were acquired by the Government during the war. The lease of these claims to the U. S. Vanadium Corporation on a royalty basis is provided for in the contract.

The signing of the new contract completes arrangements for the operation of all five of the existing uranium-vanadium ore-processing plants in the Colorado Plateau area. On April 11, 1948, when the Commission announced its Domestic Uranium Program, only two of the plants were in operation—one at Naturita, Colo., owned by the Vanadium Corporation of America, and one at Rifle, Colo., owned by the U. S. Vanadium Corporation. Since then, the plant at Durango, Colo., has been placed in operation under Commission ownership, and the plant at Rifle has expanded production and begun ore purchases from independent miners in the area. The plant at Monticello, Utah, has been purchased by the Commission and is now being redesigned and improved. It is expected to be in operation by July.

As a result of this program, the Commission expects the uranium-vanadium mining and processing operations on the Colorado Plateau to be sustained at or above the highest level ever reached.

Materials Handling

THE need to make a usable product out of low-grade iron ores is creating a new ore-processing industry which will require handling and processing equipment of new design and startling potentialities, Harold Von Thaden, vice-president and general manager of the Robins Engineers Division of Hewitt-Robins Inc., said recently. He predicted that because of new materials-handling problems in iron ore, as well as in coal production, the belt conveyer and related heavy conveying techniques will undergo their greatest technical development in history in the next 10 years.

He addressed the Fourth Annual Time Study and Methods Conference sponsored by the Society for Advancement of Management and the Management Division of The American Society of Mechanical Engineers.

There has been for some time a great deal of research into processes for making synthetic liquid fuels from coal, shale-oil deposits, and natural gas, he said. The coal and shale must be handled quickly and cheaply in huge quantities, if the processes are to be successful.

Plans of the Bureau of Mines call for the establishment, over a period of 10 years, of a synthetic-fuels industry capable of producing 2,000,000 bbl of fuel products every day, which on an annual basis is approximately 36 per cent of the total crude-oil production last year.

In plans submitted last November, the coal industry would be called upon to furnish the raw materials from which to make half the daily production of these 2,000,000 bbl of synthetic fuel. That would call for 1,000,000 bbl of fuel products to be made from coal each day. Since it takes more than half a ton of average bituminous coal to make one barrel of synthetic fuel, it means the mining and handling of more than 200,000,000 additional tons of coal a year to get the 1,000,000 bbl of fuel per day. Roughly half of the raw-material production is planned to come from mines east of the Mississippi and half from the coal and lignite deposits west of the river.

Fuel plants located right at the mine are a possibility; automatic mining machines, with transportation handled wholly by conveyers, may point the way to great savings in this important field, he said.

The idea of conveyers entering the common carrier field had not received much attention until the projected 130-mile conveyer proposed from Lorain, Ohio, on Lake Erie, to the Ohio River was announced recently. Spur lines of about 27 miles are planned to serve Youngstown and Cleveland.

The two-way conveyer will carry ore from the Lakes to the Ohio River and coal from the Ohio River north to Lake ports. At a load of 20,000,000 tons per year, savings on coal shipments would be in the neighborhood of from 81 cents per ton to $1.50. Savings on 32,000,000 tons of ore a year will amount to as much as 68 cents a ton.

Estimated over-all annual savings range between $20,000,000 and $45,000,000, depending upon the tonnages carried. This is the kind of savings which touch everybody and can mean something in terms of increased living standards. He asserted that the successful application of belt conveyers to problems of

this magnitude can easily lead to a revolution in our thinking about the transportation of bulk materials.

He pointed out that although it would be foolish to say that belt-conveyer systems can match great railroad systems, conveyers can supplement railroads under many conditions. They can be used to carry materials of certain kinds to railheads over terrain that makes a profitable rail operation impossible. Conveyers require less equipment, they can handle much tougher grades than railroads. In some countries of the world it may be possible eventually to by-pass the railroad era as it was developed in this country.

South Africa was cited as a case in point by Mr. Von Thaden. The narrow-gage railroad system there with its light equipment was designed as the lowest-cost type of transportation to handle the original requirements of the gold and diamond mining fields. These were located many miles inland with stops along the way few and far between. Today we are beginning to realize that the South African industrial and manufacturing potential is high. They have coal reserves estimated at about 25,000,000,000 tons of which they mine only one tenth of one per cent a year. Other manufacturing and industrial operations are being established. It seems likely that at some future date belt conveyers will play an important part in the development of a much higher degree of industrialization of South Africa than is now possible under its present transportation system.

If we are to protect our domestic sources of iron ore (by processing the lower-grade ores), provide fuel for the rapidly rising electric power requirements and, on top of this, produce synthetic fuels from coal, we will have to prepare to recover 400,000,000 more tons of iron ore annually, and better than 250,000,000 more tons of coal each year.

This presents a staggering problem in bulk materials handling in the next 10 years. He ventured to say that these tonnages cannot be recovered economically or efficiently without widespread application of the belt conveyer.

The materials-handling problem must be solved, he said, because only by finding better ways to increase production at lower cost can the nation maintain a constantly increasing standard of living for its people.

Research and Development

A REPORT covering unclassified research and development progress in the Department of the Army during the past year has recently been released by the Secretary of the Army.

The report discloses that the major activities of the Ordnance Department were conducted in the fields of guided missiles and rockets, artillery, ammunition, and tanks and automotive equipment.

Definite advances have been made in rocket propulsion, rocket design, and most important, on rocket guidance, which is the most difficult problem of the three. The first United States designed, ground-launched, guided rocket was successfully fired during 1948, as was also a German V-2 incorporating a newly designed guidance system.

The supersonic wind tunnel at Aberdeen Proving Ground has been used by all national defense agencies for determining aerodynamics for guided missiles, and has been the main source of this information. Considerable data have been accumulated from tests to determine the vulnerabilities of airplanes and missiles, and several important studies have been prepared using these data. A 16-in. telescope, developed for use in photographing guided-missile flight, and installed at the Ordnance Guided Missile Proving Ground at White Sands, N. Mex., also adds to our capabilities for gaining much-needed basic information.

New types of artillery were under development which will increase both fire power and accuracy and at the same time decrease the weight of weapons for the infantry and artillery.

Satisfactory advances were made in automotive equipment and tank design, mainly in the nature of improved components such as engines, transmissions, tracks, suspension, fire-control systems, and others, with the objective of providing basic types interchangeable among a wide variety of new vehicles. Included in the program are three families of air-cooled gasoline engines and parallel developments of related assemblies.

The Signal Corps also completed a successful year in the development of materiél and techniques within its scope of responsibility.

The radio program achieved several major objectives. Service tests were accomplished on a series of vehicular, tank, and ground portable radio sets for artillery, armored, and infantry use, and development models of a series of manpack radio sets for front-line use were delivered to Army Field Forces for test at the close of the fiscal year. Notable progress was also made in rear and intermediate area radio-relay equipment and new projects were initiated for the development of long-range, high-frequency radio equipment. In the field of radio direction finding, progress was made in development of equipment for military-intelligence applications, meteorological purposes, and navigational aids.

The wire-communication program emphasized engineering, equipment development, and investigation of new techniques. Examples of equipment recently developed are new lightweight rugged immersion-proof teletypewriters and field telephone switchboards.

Development of ground radar, so successfully used during the past war, was even further extended in its application to fire control, guided missiles, and meteorology.

The main trend of research and development in the Quartermaster Corps during the year was improvement of the efficiency of combat troops operating under adverse environmental conditions.

The approach was through (1) study of man's protective needs from physiological and climatic points of view, (2) the designing of prototype items of clothing, rations, and shelter, and (3) testing of men and quartermaster items under wet-cold, wind-chill, and hot-dry conditions.

Improvements were made in basic materials and processes such as a synthetic rubber with better flexing properties at low temperatures, an improved tannage, and a lighter-weight fire-resistant fabric treatment. Protection was improved in clothing and shelter.

The Corps of Engineers initiated service tests on several important items such as low ground-pressure tractors, airplane landing mats, and rubber-tired earth-moving equipment. Also, projects were initiated on such equipment that will be capable of taking part in air-borne operations and still be powered adequately for heavy construction in forward combat areas.

Development of infrared components has resulted in improved definition and resolution characteristics, which will materially increase the range and utility of infrared equipment for surveying, range finding, night driving, and other uses. Improved mine detectors were developed that permit location of all known types of mines in any type of soil, and investigation was initiated on new forms of obstacles and new obstacle and mine-clearing methods.

The program of the Transportation Corps saw the completion of an 80-ft sectionalized nesting barge which is undergoing service tests, and completion of design of a mobile floating dry dock, including complete repair facilities for small vessels. Study of the employment of the naval principle of cycloidal propulsion on mine planters and tugs progressed to the pilot

test stage. Also, in the field of water transport, close liaison was maintained with the Coast Guard in development and testing of lifeboats and life-preserving equipment, and with the Navy and Maritime Commission in design of vessels and components. In the rail-transport field, work continued on a design for a new series of Diesel-electric-type locomotive possessing maximum interchangeability of components and limited to a minimum number of sizes.

Recording Torque Magnetometer

A NEW electronic instrument that measures and records automatically the mechanical torque exerted by a uniform magnetic field on a circular disk of sheet iron or steel to determine uniformity of its magnetic properties has been developed at the Research Laboratory, United States Steel Corporation of Delaware, Kearny, N. J. The recording torque magnetometer uses flat steel samples about one inch in diameter. It makes a recorded reading in six minutes.

Two typical practical applications in which measurements of this kind have proved useful are: (1) in testing improved high-grade silicon steels for electrical transformer cores, in which superior magnetic properties are desired in the rolling direction; and (2) in controlling production of tin plate with uniform drawing properties for the manufacture of such products as bottle caps. In the latter case, magnetic anisotropy, as indicated in the torque test, gives a clue to the amount of preferred orientations present in the crystallographic structure. This in turn indicates the extent of the directionality to be expected in the mechanical properties. Hence the recording magnetometer provides a new tool that will be valuable in studying drawing qualities of steel used in such important applications as automobile fenders and bodies.

While measurement of magnetic torque is not a new development, in the present instrument the torque exerted on the disk is converted by a resistance strain gage to a small direct-current voltage that is applied to the measuring circuit of a "strip-chart" voltage recorder of the proper sensitivity. The sample disk is rotated about an axis perpendicular to its plane by a synchronous motor driving through reduction gearing.

The chart paper in the recorder also is driven by a synchronous motor, so that there is a definite relation between the angular rotation of the disk and the movement of the chart paper. As

FIG. 7 OVER-ALL VIEW OF THE TORQUE MAGNETOMETER AND ITS CONTROL CABINET

the disk rotates, the torque varies, and the pen in the recorder moves in accordance with this variation. By use of the proper conversion factor, the voltage recorded on the chart paper becomes a plot of torque versus angle of orientation of the disk in the magnetic field, using the rolling direction as the reference.

A view of the complete installation is shown in Fig. 7. The unit on the table at the right is the torque magnetometer, consisting of the electromagnet, the torsion gage, the specimen mounting, and the drive which rotates the specimen in the magnetic field. The cabinet at the left contains the recorder and the control equipment necessary for operating the instrument. The controls on the top panel permit the operator to vary the sensitivity of the gage. Thus allowance is made for selection of values of the conversion factor to alter the torque scale on the chart for different types of material and to compensate for different thicknesses. Controls on a bottom panel (not visible in Fig. 7) provide adjustment of the current through the magnet to regulate the strength of the magnetic field.

The torque magnetometers which have been put into service up until now require specimens one inch in diameter and from 0.010 in. to 0.100 in. thick, but the suitable changes in design specimens of other dimensions could be accommodated. The total torque on a specimen is proportional to its volume, so that for some materials, for example, tin plate, which are thin and have a low torque per unit volume, it is particularly desirable to increase the diameter in order to increase the effective sensitivity of the instrument.

New Flight Instrument

IN the opinion of experienced pilots who have used it, the zero reader, a new and revolutionary type of flight instrument, can lower ceilings from 400 to 100 ft, members of The American Society of Mechanical Engineers were told recently at a Metropolitan Section meeting at the Engineering Societies Building, New York, N. Y.

Although developed and designed particularly for aircraft use by the Sperry Gyroscope Company, its principle is adaptable for simplification of the manual control of many complex mechanisms, Spencer Kellogg and C. F. Fragola, of the Sperry Company, said in a paper presented to the engineers.

The practical performance of this instrument has been demonstrated in hundreds of flights, including flights by the U. S. Air Force and most of the commercial airlines. Many of these demonstrations were conducted entirely by the Air Transport Association.

Explaining that the zero reader is a "synthesizer," the authors stated that by appropriately combining data from basic flights and navigational instruments in its control unit, it reduces the most complex simultaneous demands of attitude, altitude, heading, navigational and instrument-landing requirements to a net demand of simply maintaining attitude.

By separating the "plan of flight" from the "mechanism of flight," flying with the zero reader consists of once setting the plan and then following it by merely making indicated attitude changes as dictated by instantaneous deflections of the zero reader indicator.

They pointed out that the great simplification of aircraft control which the zero reader provides, permits the pilot much more freedom to monitor proficiently all other conditions pertinent to safety of flight. It enables the pilot to achieve greater accuracy and performance with less expended skill and effort.

Use of the zero reader was not advocated as a primary flight instrument because it does not give any fundamental data of the

aircraft or what it is doing. It only tells the pilot that he is flying "according to plan." The indicator, in general, shows neither pitch, roll, heading, altitude, nor departure from the radio beam. For this specific information, the primary instruments, such as the attitude gyro, gyrosyn compass, altimeter, and conventional radio deviation indicator must be relied upon.

Although automatic approach, developed and proved before the zero reader, has been providing excellent performance, it is expected that the zero reader can serve as a good stand-by, the authors stated. They said that the reader should encourage pilots to accept automatic approach more readily.

To be an effective stand-by, the zero reader should give the pilot confidence that he could consistently make manual approaches with it, they continued. To serve this function, the zero reader has been kept absolutely independent of the gyropilot or automatic approach equipment.

The zero reader consists of a source of gyro stabilization in the form of a vertical gyro for pitch and roll signals, and a stabilized compass for yaw or heading signals. To this source is added various control functions such as altitude and radio-beam signals. These signals are carefully combined such that roll, heading, and radio beam control the vertical pointer, while pitch, altitude, and glide path control the horizontal pointer of the indicator.

Rotating Carrier

A ROTATING travel carrier and crane on which it operates has just been put into operation in a large warehouse for the handling of coiled rod and wire, by the Cleveland Tramrail Division of The Cleveland Crane and Engineering Company, Wickliffe, Ohio. The materials-handling problem here was unusual in that it was necessary to not only pick up coils of rod from incoming railroad cars, but to turn them 90 deg when placing into the large storage bins. Because of this and the fact that rod is handled by a hairpin-type hook which is tilted either up or down when threading into or drawing away from coils, the following travel motions were required: hoisting, tilting, trolley travel, bridge travel, and rotation.

The equipment consists of a crane which travels the length of the storage building, a trolley which travels on the bridge from side to side of the building, and a rotating carrier that operates on a circular track built into the trolley. The carrier has two separate hoists, cables from which are reeved to the two ends of the hairpin hook.

All motions of the equipment are controlled by the operator in the cab attached to the carrier. He can run the unit to any point in the building and turn the carrier clockwise or counterclockwise through short arcs or complete turns, thereby turning the hook to any direction desired. The hook can be raised, lowered, tilted upward or downward by separate or simultaneous operation of the hoists.

Speeds of this equipment are: bridge 400 fpm, trolley 200 fpm, hoist 50 to 80 fpm, and rotation 75 fpm. Bridge and trolley control are variable five-speed magnetic with dynamic braking. Hoist control is variable-speed drum-type with dynamic lowering. Rotating control is automatic accelerating.

The cab is open-type with landing platform and has glass and grating in the floor. A safety switch in the cab can stop all motions in case of emergency. A motor-driven horn and floodlight are also provided.

This unit was designed to carry 3500 lb of rod in addition to the weight of the hairpin hook. Similar equipment can be furnished for other capacities and operating speeds. Variations of this equipment can also be designed for other materials-handling purposes.

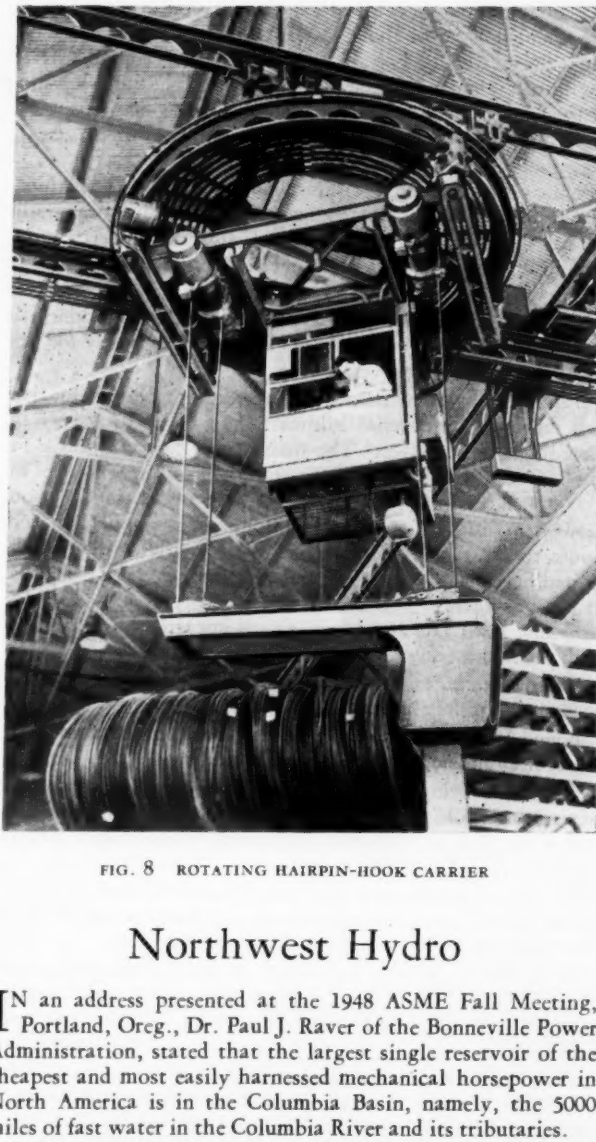

FIG. 8 ROTATING HAIRPIN-HOOK CARRIER

Northwest Hydro

IN an address presented at the 1948 ASME Fall Meeting, Portland, Oreg., Dr. Paul J. Raver of the Bonneville Power Administration, stated that the largest single reservoir of the cheapest and most easily harnessed mechanical horsepower in North America is in the Columbia Basin, namely, the 5000 miles of fast water in the Columbia River and its tributaries.

In 1933 construction was started on Bonneville and Grand Coulee dams. There was very little conscious thought given to the world-wide importance of mechanical horsepower in the beginning. The dams were authorized and begun primarily as public-works projects to make jobs, he said.

It was pointed out that the million-acre irrigation project to which water was to be pumped by mechanical horses at Grand Coulee was a waste of funds.

One way or another, however, these two great power producers were completed, and the power was gradually put to use. Then came World War II, and the importance of mechanical horsepower became paramount to all else.

Grand Coulee and Bonneville power made possible more than one third of the light-metals production which went into our own and our allies' airplanes; they supplied power to the high-speed fabricating tools which performed the shipbuilding miracles of modern times; their power produced the fissionable materials at the Hanford Project which brought the Japanese war to a rapid end.

In accomplishing those things, Bonneville and Grand Coulee power have created huge industrial pay rolls and taxable plants which operate in times of peace and to date have returned

$125,000,000 gross to the Federal Treasury on a gross capital investment thus far of about $300,000,000.

It is the conversion of a small portion of the Columbia River flow into mechanical horsepower that has done this, he said; yet there is still lacking in the minds of a great many people a sufficiently sharp realization of the importance of this basic energy supply.

Public understanding is still insufficient, Dr. Raver explained, because in spite of this tremendous record, there has been nothing but the most dilatory and casual effort to convert the remaining undeveloped 90 per cent of basic Columbia River energy into usable goods.

Today the entire dependable power capacity of Bonneville and Grand Coulee dams has been committed, not only for this year, but for the next several years.

During the past few months, applicants for nearly a quarter of a million of industrial kilowatts had to be turned away, according to Dr. Raver. The inability to provide power for these plants is costing the region employment opportunities for 25,000 men, and a loss of taxable wealth amounting to about $25,000,000 in plant investment alone. Yet population continues to grow at a faster rate in the Northwest than in the United States as a whole—39 per cent increase here from 1940 to 1947, as against 9 per cent for the country as a whole. The economic health of the region is thus impaired by a failure to keep pace with our energy base requirements.

He cited as an example, failure to provide for expansion of production in the aluminum industry.

Bonneville and Grand Coulee power now produce about half of the nation's output of primary aluminum, he said.

The metal being produced in the five reduction plants and one rolling mill is being used in more than 4000 applications, and is applied in industries employing more than 1,000,000 workers throughout the country.

Dr. Raver emphasized that the Bonneville agency has no power to sell to aluminum producers for their normal peacetime development.

If we should be unlucky enough to have a war in the next three or four years, he said, it would be just too bad. It takes many months to build an aluminum plant. It takes five years to build a new dam.

Only one new dam has been started on the main stem of the Columbia River, and at the present rate of appropriations it cannot possibly be completed before 1954, which is six years away.

Dr. Raver pointed out that hydro resources require vast amounts of capital. The Columbia River is an outstanding example of this. The St. Lawrence project is another. Power developed from such projects is low in unit costs per foot-pound, but in view of the nonreimbursable uses of the dams such as flood control and navigation and the long-term risks involved in the reimbursable uses, power and reclamation, their development on a large-scale river system such as the Columbia takes more long-term risk capital than can be privately banked.

If the Federal Government is to do the job in the Northwest, he stated, it must recognize that the power aspects of the development are basic to the economy of the region and, indeed, to the nation. This means that power development on the Columbia River system must be differentiated from public works in both the planning and budgeting of the Federal Government. No longer can we build dams for power in this region on a public-works basis only. The power supply must be programmed in accordance with the needs of a growing economy and an expanding population. This fact poses one of the most serious problems facing the people of the Northwest and their government.

Automobiles

Record

Sixty-three American stock-car records were certified as broken by a 90-hp 4-cyl Austin A90 convertible which, on April 18, finished a high-speed long-distance endurance trial, in which it covered 11,850 miles in seven days at a net speed for the entire run of 70.54 mph. The run was made in Indianapolis, Ind. The Contest Board of the American Automobile Association, under whose sanction the trial was held, announced these figures as official, after tearing down the Austin to confirm that the British car was actually an ordinary stock model.

Among the 63 American stock-car records broken were the "fastest five miles," when 89.58 mph was maintained. Of the other records, 47 were in the Class "D" open-car division, and 16 in the unlimited class.

This is said to be the first time that any car has broken so many records in one run, and it is also the first time that any non-American stock car has challenged American domestic records.

Small Car

Great Britain also is now making one of the world's most economical small cars which, although it holds three people, consumes only one gallon of gasoline for every 103.3 miles. The car is already in production, though for the time being on a small scale, at Preston, England. The manufacturers have already booked 4000 overseas orders. The rate of production is 50 a week and though 90 per cent have been allocated to overseas, it may take two years to complete the present overseas bookings, unless production can be increased.

The new car is the "Bond Minicar," a three-wheeler of revolutionary design. Its designer, Laurence Bond, was chief engine designer to the Blackburn Aircraft Co. (Lancashire), when he began to plan a really cheap car. When the first car was delivered to the London distributors some weeks ago, it covered the 247 miles from Preston to London at a cost of half-a-cent a mile, setting up a world record for cheap car travel.

The Bond Minicar has a $3^{3}/_{4}$-hp single-cylinder two-stroke engine, a three-speed gear box, powerful brakes, and a top speed of about 50 mph.

The first car coming off the production lines made the Preston-London trip under official observation. Carrying one passenger and his driver, it averaged more than 30 mph.

Light Cars

The prototype of a 40-mile per gal 75-mph light car is nearing completion at the works of James Fairley and Sons, Sheffield, England. One early model of the Fairley has been tested on the roads, and reached speeds up to 75 mph with an average gas consumption of 40 miles per gal. Now nearing completion, it incorporates many improvements. It has balloon tires with chromium-plated wheel disks, a large space for luggage, and in order to make access to the engine easy, the whole front of the bodywork can be raised with one hand. A similar car with a 36-hp high-performance engine of the latest design is also planned.

The Standard Motor Company, Conventry, England, has completed the design of a small Triumph, extremely light and cheap, which will be produced in quantity for export concurrently with the firm's Vanguard now being produced at the rate of 230 a day.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Pipe-Flange Tests

Fatigue Tests on Flanged Assemblies, by A. R. C. Markl and H. H. George, Tube Turns, Inc., Louisville, Ky. 1949 ASME Spring Meeting paper No. **49—S-6** (in type; to be published in Trans. ASME).

Qualitative differences between the various types of pipe flanges in common use have long been recognized, but their quantitative evaluation in terms of rules, formulas, or ratings which could be used as a guide by the practicing engineer has been accomplished only partially. Two problems are involved, i.e., the determination of the strength and tightness of a flanged assembly under internal pressure, and the other the effects of the variable bending moments associated with mechanical vibrations or temperature fluctuations of the flowing medium or surrounding atmosphere. The present investigation is intended to contribute toward an understanding of the latter phase; stress-intensification factors are reported which have been obtained from fatigue tests of full-scale assemblies of 4-in. flanges of the 300-lb ASA pressure class and hence are directly applicable to piping flexibility calculations.

Cyclically reversed bending tests were carried out on assemblies involving the following types of commonly used flanges: (*a*) Slip-on flanges, (*b*) socket-welding flanges, (*c*) welding neck or butt-welding flanges, (*d*) ring flanges, (*e*) lap-joint flanges, and (*f*) threaded flanges.

The test established that even under unusually severe bending stresses, flange assemblies do not fail in the flange proper, or by fracture of the bolts, or by leakage across the joint face. Structural failure occurs almost invariably in the pipe adjacent to the flange, and in rare instances, across an unusually weak attachment weld; leakage well in advance of failure is observed only in the case of threaded flanges.

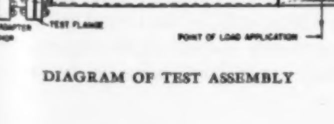

DIAGRAM OF TEST ASSEMBLY

While it is the pipe that fails, the type of flange is influential in determining the endurance strength of the assembly, largely by the way in which it affects the stress transfer at the joint. The smooth tapering transition, afforded by a welding neck flange, provides an endurance strength of the assembly equivalent to that of a butt-welded joint between two pieces of pipe, which itself is not greatly different from that of unwelded straight pipe to judge from indications obtained from tests in such pipe conducted by the authors. A fillet weld presents less favorable conditions owing to the sharp change in cross section and stress flow direction. In the case of lap-joint flanges, the transition would not appear unfavorable, but the lap apparently lends inadequate support to the neck of the stub end. Finally, in the case of threaded flanges, the reduced pipe-wall thickness and notch effect, caused by the threading, constitute weaknesses which become even more apparent under cyclic loading than under static conditions.

Hydraulic Efficiency

The Concept of Hydraulic Efficiency as a Measure of Compressor and Turbine Performance, by W. E. Trumpler and P. R. Trumpler, Clark Brothers Co., Inc., Olean, N. Y. 1949 ASME Spring Meeting paper No. **49—S-7** (mimeographed).

An extensive study of flow thermodynamics concerned particularly with centrifugal-compressor problems was made in a recent paper. One of the conclusions proposed the adoption of "hydraulic efficiency" as a performance criterion for a compressor. It is the purpose of this paper to support the proposal, to establish a general theoretical basis for hydraulic efficiency, and to show its relation to other efficiencies used in practice.

The term hydraulic efficiency, embodying the same basic idea developed in this paper, is not a new one. One author has used it for 15 years in industrial centrifugal-compressor practice. Yet the concept is not generally understood, at least among the manufacturers of this country, and the term hydraulic efficiency is not in general use here as a compressor and turbine performance criterion.

The authors define hydraulic efficiency as the ratio of total work done on a fluid stream minus the work dissipated by fluid friction to the total work done on the stream (compressor) or the ratio of work removed from a fluid to the work removed plus the work converted to friction (turbine). The concept is applicable, and has been successfully applied to a wide variety of problems. It is simple to use in most practical cases, particularly in the field of multistage centrifugal and axial compressors, and gas turbines.

In this paper the authors relate many of their comments specifically to compressor problems, although similar conclusions hold for turbines. Many equations applicable to turbine problems are given.

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Steam Power Station

The English Station Extension, by R. L. Anthony and J. O. Mullen, Westcott and Mapes, New Haven, Conn., and C. A. Molsberry and E. H. Walton, The United Illuminating Company, New Haven, Conn. 1949 ASME Spring Meeting paper No. 49—S-8 (mimeographed).

This paper gives a brief description of the extension of the United Illuminating Company's English Station in New Haven, Conn., and discusses some of its features.

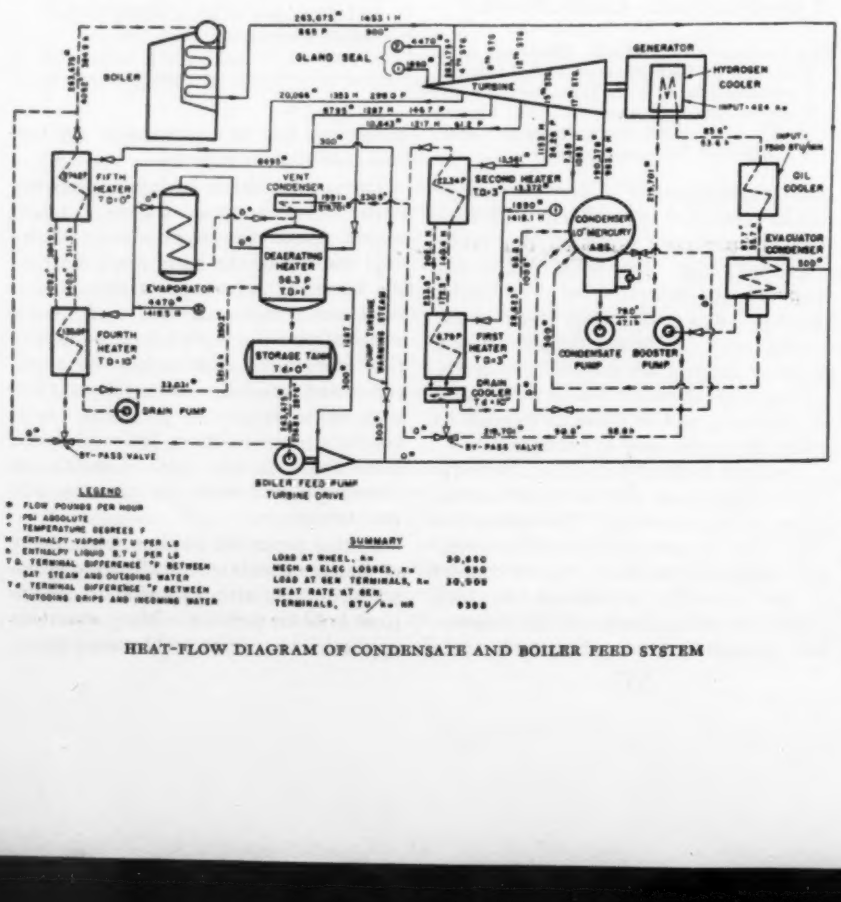
The boiler is of the radiant type, fired vertically downward, with spray attemperator to control the steam temperature. Its rated continuous output is 320,000 lb per hr at 900 psi, 910 F. It is fitted with continuous tube drainable superheater and economizer, regenerative air heater, and automatic soot blowers using steam. There are two pulverizers, four coal burners, and eight load-carrying oil burners, together with four electric-ignition oil burners.

The forced and induced-draft fans, one of each placed above the boiler, are each operated by two motors of different speeds and have vane control. The fans, together with their motors, rest on slabs which are placed on spring supports; the springs were installed to guard against the possibility of transmitting vibrations to the building. An electrostatic precipitator having a guaranteed efficiency of 95 per cent is placed between the air heater and the induced-draft fan. Ash is removed dry by a vacuum system.

The turbine-generator is an AIEE-ASME preferred standard 30,000-kw 3600-rpm hydrogen-cooled machine rated at 0.85 power factor and having five extraction stages. It exhausts to a 27,000-sq ft single-pass surface condenser that has double water boxes to permit either half of the condenser to be used if the other is out of service.

The expected over-all heat rate of the extension at full load is 11,400 Btu per kwhr. The normal load range is from 13,000 kw to the maximum capacity of the turbine.

In general, all auxiliaries are motor driven. Pumps are installed in duplicate, each large enough to carry something more than rated load on the turbine. There are, however, three boiler feed pumps, two of which are motor-driven while the third has a steam-turbine drive and starts automatically on loss of feed-water pressure.



HEAT-FLOW DIAGRAM OF CONDENSATE AND BOILER FEED SYSTEM

Education and Training

Apprenticeships in Manufacturing Management, by A. V. Feigenbaum and H. W. Tulloch, General Electric Company, Schenectady, N. Y. 1949 ASME Spring Meeting paper No. 49—S-11 (mimeographed).

In the field of training for manufacturing management, experience has indicated that effective educational programs must be established on a personal basis. Leadership skills have been most readily developed by those men who have had the good fortune in their careers to work under the guidance of seasoned successful managers of men.

This situation is recognized by the Apparatus Department of the General Electric Company in its Manufacturing Leadership Program. The core of this pattern of planned leadership development is the "personal apprenticeship" of young men, selected for their administrative potential, to experienced manufacturing executives.

The program also includes training of the young men in modern manufacturing techniques, and their rotation among several different manufacturing responsibilities. An over-all picture of the entire scope of product manufacturing is fostered, since men are being developed for major manufacturing positions.

Apparatus Manufacturing has recognized in its program the wide variety of managerial "styles" among executives. Two equally successful administrators may vary widely in their individual personalities, backgrounds, and interests. So the Manufacturing Leadership Program—or "Management Apprenticeships" as it is frequently called—is tailored to fit the individual needs of trainees. Standardization of assignments is carefully avoided. Trainees participate directly in the formulation of their training schedule and assignments.

Organization of the program is based on the fact that the most effective point at which management development can take place is between a trainee and the experienced executive who is his superior. Training is an important part of the function of the line organization, and the primary training job is carried on by the line. Staff activity in management training is to assist the line in carrying on this program, to co-ordinate the program, and to stimulate an awareness of the importance of this training at all levels of manufacturing management.

Marine Fouling

Control of Marine Fouling in Sea-Water Conduits and Cooling-Water Systems Including Exploratory Tests on Killing Shelled Mussels, by H. E. White, Stone and Webster Engineering Corporation, Boston, Mass. 1949 ASME Spring Meeting paper No. 49—S-12 (mimeographed).

Marine fouling develops at such a rate at some coastal sites that it can become a major factor in design of the circulating-water system of a steam-electric power station. In absence of suitable control treatment, hundreds of tons of mussels may accumulate in the tunnel system of a large power station in a single season. Similar conditions arise in connection

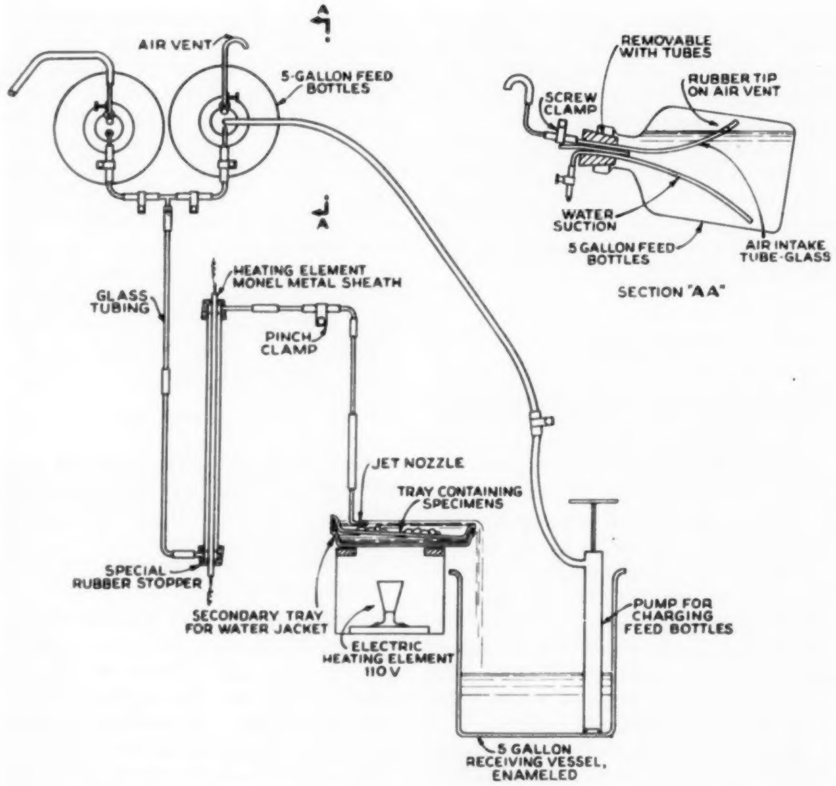


DIAGRAM OF TEST EQUIPMENT

with sea-water systems of industrial plants. Even where some degree of control has been employed, accumulations of mussels have reached serious proportions. In some cases complete plant shutdowns have been required periodically for scraping and digging out mussels by hand labor.

With high plant investment and heavy demands for output and continuity of power supply, shutdowns for cleaning tunnels become increasingly objectionable. Continuous 100 per cent cleanliness of tunnels is desired in some plants to avoid periodic cleaning, though the normal intervals between cleanings may be several years. This view is prominent particularly (1) where tunnels are long, (2) where access is difficult, and (3) where labor conditions are unfavorable.

The objectives of the present project were, first, to determine, if feasible, a practical procedure for control of marine fouling which would give full assurance of 100 per cent extermination at will under severe conditions with minimum chlorine consumption, and second, to determine the limitations of control treatments. Divergent opinion on detail questions left no alternative but to make detail observations. The specific objective therefore was to determine practical procedures which would give positive control of marine fouling based on more specific quantitative observations of actual results of treatments than had been available.

Exploratory tests demonstrated great practical influence of very moderate changes in temperature of the sea water in extermination of mussels. Any elevation of temperature reduces the required consumption of chlorine, which has been the usual killing agent. For plants with suitable arrangements and load conditions, it appears practical to achieve positive control of marine fouling in tunnels without chlorine or other chemicals by periodic increase of sea-water temperature to not more than 95 F for northeast coastal plants.

Numerical results of various treatments as observed in the tests are summarized by charts.

Control of Marine Fouling by Temperature at Redondo Steam Station of the Southern California Edison Company, by W. L. Chadwick, Mem. ASME, Southern California Edison Company, Los Angeles, Calif.; F. S. Clark, Mem. ASME, Stone and Webster Engineering Corporation, Boston, Mass.; and Dr. Denis L. Fox, Scripps Institution of Oceanography, Division of the University of California, La Jolla, Calif. 1949 ASME Spring Meeting paper No. **49—S-13** (mimeographed).

This paper describes a system of controlling marine fouling by elevating the temperature of the sea water, and presents the results obtained during the first year's operation.

The circulating-water system consists of two 10-ft-ID precast concrete pipes laid in the floor of the beach in trenches having a minimum earth cover of 4 ft and extending into the sea for a distance of about 1900 ft. The terminal structures are vertical precast concrete towers 14 ft in diam extending about 10 ft above the sea floor and protected by a riprap. The top of these towers is about 20 ft below mean lower low water. They are separated laterally 200 ft to avoid recirculation of the water.

The shore end of each concrete pipe is connected to a concrete structure in which there are four vertical steel gates which can be raised or lowered with electric motors. The gates are arranged and operated so that one of the concrete pipes acts as an intake and the other as a discharge conduit. At intervals the position of the gates is changed so that flow is reversed in each conduit. In this way either conduit may be used alternately as a discharge or intake.

During the months when the ocean water exceeds 60 F, the gate positions are reversed periodically, causing a reversal of flow in the two lines so that the line which acted as the intake line be-

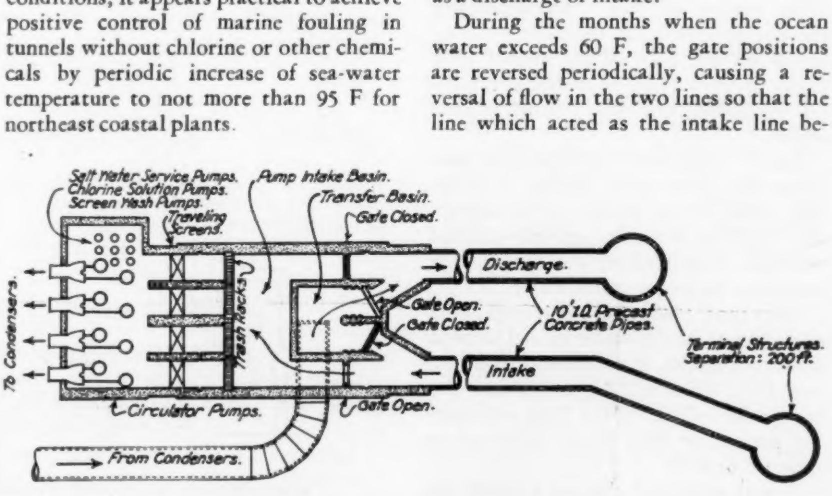


DIAGRAM OF CIRCULATING-WATER SYSTEM

comes the discharge line. As soon as this happens, the temperature of the water in the line increases about 19 F if full load is being carried in the plant. Depending upon the ocean-water temperature, this is further increased by partially opening one of the gates to cause recirculation of the water to the condenser until the temperature of the water flowing in the discharge pipe is raised to about 102 F. Fouling organisms cannot survive this temperature for longer than one hour. To make certain that all mussels and other growths are killed, this temperature has been maintained for four hours during the first summer before restoring the gate to normal position and stopping recirculation.

This treatment, it is claimed, has resulted in the pipes and terminal structures remaining completely free of any fouling organisms.

Project Study for the Mitigation of Marine Fouling, by I. A. Patten, Lynn Gas and Electric Company, Lynn, Mass. 1949 ASME Spring Meeting paper No. **49—S-20** (mimeographed).

This paper outlines experiments and the development of a chlorine program of the Lynn Gas and Electric Company of Lynn, Mass., which to date has proved effective and economical.

Included in the development was a reinforced-concrete intake-water tunnel for condenser cooling purposes. The tunnel as designed provided for one concrete rectangular tube, 7 ft sq near the intake and of progressively decreasing cross section, approximately 250 ft in length.

In 1931 it became necessary to unwater the tunnel and do a thorough cleaning job. This resulted in the removal of approximately 160 tons of mussels and other marine growth. Accompanying the marine growth, there was an accumulation on the floor of the tunnel to a depth of 18 to 24 in. of harbor silt, mussel excretion, and many dead mussel shells.

Before a successful chlorination program was developed, several methods were tried which proved to be impractical for that particular station—manual removal, electrocution, and temperature treatment by steam or hot water.

Since June, 1948, after the inspection of the concrete intake-water tunnel showed favorable results, a program of continuous chlorination at 0.5 ppm residual was set for the balance of the 1948 propagating season, or until water temperatures dropped to 40 F.

It was estimated that as a result the 1948 gross operating savings for the Lynn Station were \$20,000. These savings consisted of avoiding the intake-tunnel cleaning, fewer condenser outages and cleanings, and higher vacuum with a resultant reduction in coal usage.

Deducting from this the gross operating cost of the chlorine plant, the direct cost for chlorine purchases, interest, taxes, and depreciation on the chlorine plant, the estimated net saving for the year is about \$12,000.

Fuels

Furnace Performance With Overfire Jets, by William S. Major, Mem. ASME, Bituminous Coal Research Inc., Pittsburgh, Pa. 1949 ASME Spring Meeting paper No. **49—S-18** (mimeographed).

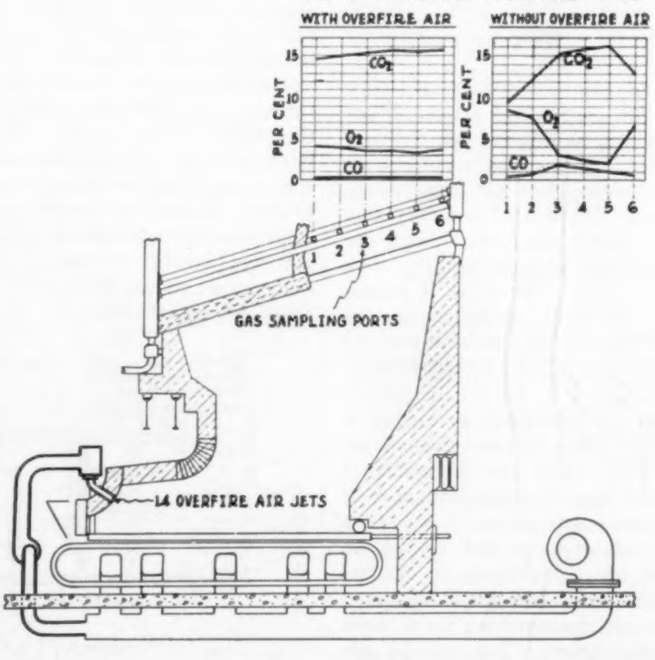
As a result of the increasing demands for reduction of air pollution, thousands of commercial and industrial plants have installed modern overfire air jets for smoke abatement. They are not only used on practically every type of existing hand-fired or stoker-fired furnaces but are also being increasingly built into most new stoker-fired furnaces.

Improvements in furnace performance have been shown on all types of stoker-fired and hand-fired furnaces by use of overfire jets. It is pointed out that maximum benefits from jets are most likely to occur on spreader-stoker-fired furnaces. In such furnaces there is a greater tendency for gas stratification when not provided with auxiliary turbulence from jets. Improvements with jets that have occurred on various types of furnaces include: (1) substantial reduction in smoke density, (2) increases in boiler and furnace efficiency, (3) reduction of both the quantity and carbon content of the cinder carry-over, (4) shortening of the flame and reduction of the final temperatures when surfaces are of the same degree of cleanliness, (5) reduction of soot and slag deposits on boiler and economizer surfaces, and (6) ability to operate with slightly lower excess air without unburned combustible gases.

Some Aspects as to the Cause and Prevention of Slag Deposits on the Heating Surfaces of Modern High-Pressure Boilers, by E. F. Walsh, Narragansett Electric Company, Providence, R. I. 1949 ASME Spring Meeting paper No. **49—S-19** (mimeographed).

Boilers designed and installed during the past eight years have been plagued more or less with objectional deposits accumulating on the superheater and economizer tubes. These deposits appear to become more troublesome with time, which would indicate a progressive effect of some nature toward the formation of slag.

As the operating pressure and total steam temperature have increased, another type of scale or slag accumulating in the cooler passes of the boiler has been



PERFORMANCE WITH AND WITHOUT OVER-FIRE JET ON FORCED-DRAFT CHAIN-GRATE STOKER

observed which also has been found very troublesome and which cannot be removed without taking the boiler out of service.

The reason for these scales or slag deposits has been studied by a number of engineers, both in this country and abroad, and a brief summary of some of the published theories and experiments is given in this paper.

It is pointed out that if a means could be found to prevent or retard the formation of sulphur trioxide, then a marked reduction in slag formation should result.

Experience has dictated that new boilers are immune to objectionable deposits for varying periods of time depending upon the type of fuel used. This indicates that until the metal surfaces have become saturated with sulphuric acid, no serious slag conditions result. Of importance then, is to thoroughly wash and neutralize all boiler surfaces when the boiler is off for inspection and cleaning. Experiments indicate that once a year is sufficient for this operation.

Iron oxide is considered a catalyst responsible for the conversion of SO_2 to SO_3. If the metal surface areas exposed to the flue gases could be reduced, then there should be less sulphuric acid formed on the boiler surfaces. An application of lime slurry ($CaOH_2$) over the neutralized metal has shown by experiment to reduce appreciably the amount of slag deposits.

The presence of sulphuric acid on a surface increases the dew point of the gases, causing the ash in the flue gases to adhere to the surface resulting in slag. This process is cumulative once the conditions for its formation become present.

Experiments indicate that if the boiler surfaces are thoroughly washed and neutralized and coated with a lime slurry ($CaOH_2$) little or no corrosion will take place and slag accumulations will be reduced.

Continuous feeding of ($CaOH_2$) to the furnace does not appear to be of any value in retarding slag formations.

It appears that if we are to have slag- and corrosion-free boilers, a protective coating must be devised that can be applied to all metal parts exposed to flue gases which will be capable of withstanding temperatures up to 1200 F.

Submarines

Submarine Maintenance and Repair, by Commander D. G. Baer, U. S. Naval Submarine Base, New London, Conn. 1949 ASME Spring Meeting paper No. **49—S-21** (mimeographed).

This paper discusses the relation of submarine operation and repair and the dependence of one upon the other.

The submarine of today is a cigar-shaped pressure-resistant envelope surrounded by non-pressure-resistant tanks and surmounted by a ship-shaped superstructure to provide for better seaworthy characteristics. This type of construction is known as the double-hull construction and grew out of the single-hull ship which had the tanks installed within the pressure envelope, and therefore partly constructed for withstanding pressure. All of the machinery items, storage batteries, and living compartments are within the pressure hull. The various tanks are free-flooding controlled venting, or controlled flooding controlled venting design depending upon the use for which the tank is intended. The superstructure which supports the main deck and which runs the entire length of the ship is free-flooding and free-venting, thus a considerable portion of the submarine when seen at the dock is completely flooded by water when the ship is submerged. The interior of the submarine is compartmented as follows: torpedo rooms, battery compartments and living spaces, control room, conning tower, engine rooms, and maneuvering or motor rooms, and pump room. In the submarine under discussion it is necessary to be on the surface to charge batteries and airbanks, although modern conversions known as Guppies provide for such operation submerged by the snorkel. These latter submarines have been streamlined and given a reduced superstructure to provide greater submerged speed.

The following subjects are discussed in the paper: Peacetime and wartime maintenance comparison, wartime maintenance, casualties, operating routines for maintenance, peacetime maintenance, submarine base or tender organization, work lists, shipyard overhauls, and the work required during each shipyard overhaul.

High-Speed Analog

The High-Speed Analog as Applied in Industry, by G. A. Philbrick, Jun. ASME, Cambridge, Mass. 1949 ASME Spring Meeting paper No. **49—S-14** (mimeographed).

The high-speed analog, which is in essence a model of convenient and flexible construction, may be applied as an automatic computer to solve such problems as those of controlled systems. Computing structures may be assembled out of basic analog components which correspond to the blocks of the engineer's block diagram. Any linear system requires only three types of component for representation, and nonlinear systems are included through the addition of further standard types.

Continuous displays of the computed results are made possible by cyclic repetition of initial conditions, so that the effects of parametric adjustments are immediately evident to the user. The advantages of this specialized tool of synthesis are especially great in the planning and study of complex multiloop control systems, where the criteria for optimum performance cannot be guessed at and resist the most advanced mathematical analysis.

This paper reviews the applications on one type of high-speed analog as applied in the general industrial field.

ASME Transactions for May, 1949

THE May, 1949, issue of the Transactions of the ASME contains the following:

- Field Control of Oil-Field Pumping Equipment, J. N. Gregory (48—PET-6)
- Operating Characteristics and Requirements of Drawworks Brake Equipment, R. G. De La Mater (48—PET-3)
- Automatic Drilling Feed Controls for Rotary Drilling Rigs, W. S. Crake (48—PET-4)
- Pressure Surges and Vibration in Reciprocating-Pump Piping, J. W. Squire, (48—PET-9)
- Continental and American Gas-Turbine and Compressor Calculation Methods Compared, P. F. Martinuzzi (48—SA-62)
- Tests on V-Belt Drives and Flat-Belt Crowning, C. A. Norman (48—A-102)
- Anisotropic Plastic Flow, J. C. Fisher (48—SA-64)
- The Laminar-Film Hypothesis, Benjamin Miller
- A Study of Three Tube Arrangements in Unbaffled Tubular Heat Exchangers, O. P. Bergelin, E. S. Davis, and H. L. Hull (48—A-34)
- Investigation of Variation of Point Unit Heat-Transfer Coefficient Around a Cylinder Normal to an Air Stream, W. H. Giedt
- A Critical Review of Skin-Friction and Heat-Transfer Solutions of the Laminar Boundary Layer of a Flat Plate, M. W. Rubesin and H. A. Johnson
- Torsional Viscous-Friction Dampers, J. C. Georgian (48—A-67)
- Two-Species Laminated Beams, A. G. H. Dietz (48—WDI-6)
- A Classification of Linear Transfer Members, H. L. Mason (48—A-84)

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

The Commercial Weldery

Comment by H. E. Hodges[1]

The excellent paper in the February issue on the commercial weldery[2] opens many channels of thought on the future of the welding industry.

As the author points out, any new method of manufacturing must embody certain improvements and economies, in order to be accepted by industry. The welding industry has earned its unquestionable right to stand alone as one of the leading new manufacturing methods; however, this new service to manufacturing must be given every possible opportunity to perform to its best advantage in order to produce satisfactory economy.

Occasionally a manufacturer has not succeeded in effecting the economy that he was led to expect from his made-at-home weldments. In investigating the underlying cause of this disappointment, it is usually found that somewhere some basic principle was overlooked, or that welding was enforced on some product that could from its very nature or shape be made better by some other manufacturing method.

Some elaboration would seem to be in order on one phase of this paper which the author mentioned rather briefly, and that is the possible economy of using a commercial weldery as a supply of welded steel parts. A commercial weldery whose existence and future are based upon recommending, designing, and producing economical sound weldments, constantly must keep abreast of the latest developments in fabricating methods, welding techniques, and shop equipment. The constant and consistent improvements in welding procedures and methods often lead to the obsolescence of older and slower methods. The cost of equipping a manufacturing plant with adequate machinery to form, bend, roll, shear, or flame-cut to size and shape the component parts of weldments is difficult to justify unless this machinery is to be maintained in operation at least 8 to 10 hr per working day. Add to this initial cost of equipment the maintenance of it, plus the improvement factor mentioned and it becomes obvious that, unless the value of the weldments represents a high proportion of the total product, such weldments could be purchased more economically as semifinished items from a commercial weldery much the same as castings or forgings are purchased. In a manufacturing plant that is welding only its own product, this expense is rarely justified where all of the cost factors are considered.

As the author points out, a manufacturing plant would rarely install its own foundry or forge shop. It undoubtedly would find that purchasing its castings, or forgings from regular well-equipped and reliable commercial jobbing shops is the most economical procedure. This same line of reasoning applies to welded steel parts. Procuring weldments from a commercial weldery would enable the manufacturer to take advantage of the professional ability of those who specialize in weldments. The commercial-weldery engineer is especially trained to investigate all of the factors pertaining to the customers' service requirements. His perceptions and understanding of these service requirements often will save costly design changes, and undoubtedly will result in good, sound, economical weldments.

Two of the most costly factors to a manufacturer in modern production are floor space and labor. The inherent character of fabricating and welding requires a much larger amount of floor space per man-hour of labor than other ordinary manufacturing operations. Few manufacturers are prepared to forfeit their high-priced floor space for this purpose when it is possible to purchase weldments more economically. The additional labor that is necessary to fabricate and weld is of a different caliber from that ordinarily employed in a manufacturing plant. It is often difficult for the average manufacturer to recruit and train sufficient extra labor of this kind to keep production going. To a commercial weldery the burden of hiring and training employees for its various operations is an everyday task and presents no unusual problems. Usually the labor for the commercial weldery will exist in a different labor area from that of the manufacturer and will not produce any undesirable labor condition to the manufacturer. The overhead burden, which all manufacturing plants must absorb, is usually higher than that caused by fabricating and welding operations only, and sometimes, when full overhead burden is applied to the welding operations, an unfavorable condition results. A commercial-weldery overhead is seldom as high as the average manufacturing overhead. These factors are sometimes intangible and often are overlooked but, nevertheless, they are always of rather large proportions.

The lack of the proper fabricating machinery for the job may lead a manufacturer making his own weldments to adopt costly makeshift weldments which may result in an uneconomical part and may possibly produce structural failure. Stress-relieving is such an important factor in weldment manufacturing that every first-class commercial weldery assumes stress relieving to be as much a part of his obligation to his customer as the actual operation of welding. Stress-relieving is not always easily available to the average manufacturer, except at considerable expense. This may lead to its omission which may possibly aggravate structural failures.

These are a few of the more obvious cost factors which should be be considered in comparing weldments made at home with weldments made by commercial welderies. There are many more that may be encountered.

Comment by S. V. Williams[3]

The commercial weldery, while relatively new, played a most vital part in our recent war efforts. It can be justly appraised as one of our best means of preparing for the future, regardless of what that future has in store. Any nation to survive in the world of tomorrow must use its materials very wisely. With speed and mobility so essential, excessive or dead weight cannot be tolerated.

[1] Manager, Weldery Division, Graver Tank and Manufacturing Company, Inc., East Chicago, Ind.

[2] "The Commercial Weldery—A New Service and Tool for Industry," by K. F. Ode, Mechanical Engineering, vol. 71, Feb., 1949, pp. 139–142.

[3] Technical Manager, Struthers Wells Corporation, Titusville, Pa.

The commercial weldery is the answer to both of these requirements as the paper being discussed states.

The author feels that welding has crept into our modern life. The writer disagrees—it has come with a bang; its effect will not be fully recognized in our generation. No enterprise throughout the world can be considered modern without the services of a weldery. In short, not since man learned to control fire has a more useful manufacturing method been made available.

As the paper points out, designing engineers find in modern welding a means of utilizing fully proved materials to their best advantage, with limitation only being placed in their design by the physical properties of the material used. This has led to the development of higher-strength alloy steels, and competitive material such as monel, everdur, aluminum, inconel, nickel, and stainless steels, wherein corrosion and contamination become a problem. The commercial weldery can utilize the full range of the properties of these materials at room, elevated, and subzero temperatures, for welded design is one of the best designs to handle rapid changes of temperature so as to minimize thermal stresses which must be coped with if leakage and progressive failures are to be avoided.

Good engineering uses the services of commercial welderies in creating modern equipment, designed to use the full physical properties of the material chosen. Generally this means low first cost, with the added assurance that the equipment will fulfill its expected life of usefulness with a minimum of maintenance cost and shutdown time.

The author has pointed out the greater impact resistance of a weldment over a casting. Where sudden loading from starts and stops, or from breakage of tools used, or rotating members, a weldment has tremendous advantage over a casting with its toughness and ability to recover from deformation. These properties of weldments permit them to be rebuilt readily or design changes to be made for improvements in operating efficiencies of processes or equipment.

Weldments have proved their ability to lead to great operating efficiencies, and are in no way a substitute for castings. Their performance has shown them to be an improvement over the old method of casting to form. Their soundness and freedom from shrink cracks and porosity, conducive to reliability, make their future use assured.

The factors enumerated by the author must be considered by the designing engineer in purchasing his weldments. In addition, it is recommended that he discuss his operating condition with the weldery engineers, who may have had a similar designing problem and practical experience which will aid in perfecting the weldment in the most economical manner.

Jet Engine Self-Starter

TO THE EDITOR:

In a recent issue[4] in connection with a brief description of a jet engine self-starter developed by AiResearch Manufacturing Company, appears the following statement: "AiResearch engineers believe these are the first radial inward-flow power turbines ever to be developed." It is further explained that the statement is not intended to apply to water or steam, but only to air or gas.

Actually, there is a fairly extensive background of experience with radial inward-flow air and gas turbines. (The term "power turbines" is redundant, inasmuch as all gas expansion turbines are power turbines; even when the primary object is refrigeration, power must be developed by the turbine. Furthermore, much of the background with radial inward-flow turbines has dealt with applications where power was the primary objective.) A good deal of work done in this field has not been published, but the following references should quickly dispel any notion that the subject application is the first of its kind:

"Turbo-Expanders," by J. S. Swearingen, Trans. AICE, vol. 43, Feb., 1947, pp. 85–90.

"The Elliott Turbo-Expander," by A. W. McClure, *Powerfax*, Summer, 1948.

"High-Temperature Gas-Turbine Power Plants," by J. S. Haverstick and A. M. G. Moody, MECHANICAL ENGINEERING, vol. 67, 1945, pp. 229–233.

Developments of this type go back at least 15 years. In this country several companies have been active in the field. Speaking only for the company with which the writer is connected, it can be stated that not only are radial inward-flow air and gas turbines in commercial service, but others are in the process of installation, and the company is actively interested in further developments in this field.

ARTHUR W. MCCLURE.[5]

[4] "Jet Engine Self-Starter," MECHANICAL ENGINEERING, March, 1949, vol. 71, p. 236.

[5] Engineering Department, Elliott Company, Jeannette, Pa.

Continuous Process for Ice Making

COMMENT BY LUIS H. BARTLETT[6]

The ice-making development described in a recent paper[7] is of great interest to the ice industry, which is intrinsically seasonal and is afflicted with the labor difficulties attached to seasonal operation. Any device which promises a saving in labor will be welcomed.

From Table 1 of the paper, the net input to the hydraulic motor is calculated as 3.75 kwhr per ton of ice produced. This will amount to approximately 10 per cent of the energy required to drive the compressors, and it would seem that some investigation of freezing surfaces is in order. It seems probable that a surface may be found to which ice does not adhere as tenaciously as it does to steel. This is of course a matter to be solved by experimental methods, but any saving of energy at this point is well worth considering.

The author states, "So far as is known, this is the only existing process for the automatic production of ice cakes." It may be interesting to note that a similar device has been described by Joseph Huber.[8] Huber claims "an apparatus for freezing liquid comprising a substantially cone-shaped freezing cell having a wide and a narrow end both ends being open, cooling means adjacent to and around said cell, a tank for storing the liquid to be frozen attached to one end of said cell and adapted to permit the liquid to permanently communicate freely between said tank and said cell, and means adjacent to said narrow end of said cell adapted to push the frozen liquid toward said wide end of said cone-shaped freezing cell, whereby a continuous block of frozen liquid emerges from said cell as fast as the liquid is frozen within said cell."

COMMENT BY CROSBY FIELD[9]

Since 1915 the writer has been engaged in the development of machinery to

[6] Director, Engineering Experiment Station, Louisiana State University, Baton Rouge, La. Mem. ASME.

[7] "Ice Making by the Extrusion Process," by J. R. Watt, MECHANICAL ENGINEERING, vol. 71, January, 1949, pp. 17–20.

[8] U. S. Patent 2,071,465.

[9] President, Flakice Corporation, Brooklyn, N. Y. Fellow ASME.

produce small ice. Although we had some technical difficulties to work out, the principal obstacle to its widespread adoption has been the opposition and the inertia of the well-established ice industry. Therefore the advent of others into the field is a welcome event.

It is easy to freeze ice onto a metal surface but extremely difficult to get it off that surface. Speaking generally, the ice may be shaved off by some form of shears or revolving cutter but in this case it is rare that the ice is truly eliminated from the surface. A thin film is usually left on the surface to prevent the cutter from actually digging into the metal underneath the ice. The first of these machines to achieve commercial success, but ultimate financial failure, was the Holden process, in which the ice was frozen on a refrigerated drum submerged in water and the mixture pumped to a hydraulic press where it was compressed into 300-lb cakes or larger. It is said that his Regealed Ice Company failed largely because the cloudy ice thus made was not acceptable to the public.

Long after this failure, the writer made and operated a somewhat similar machine but decided that it was not the complete answer to the ice-manufacturing problem. The only commercial machine at present using this principle is the very much improved Vilter's "Pakice."

Another method of getting the ice off a drum is by wedging it off by means of a pressure cutter applied approximately at 90 deg to the tangent of the curved drum surface, in a manner similar to chipping ice off a sidewalk with a handtool. The commercial machine made on this principle is one of the types of "Flakice" machines supplied by the York Corporation under Flakice Corporation patents.

A third method of dislodging the ice from a surface is the flexible belt or flexible cylinder. This produces a form of ice which has certain advantages for a large range of markets, and, since 1928, commercial machines of this type have been operating in customers' plants. This type is marketed by the York Corporation under Flakice Corporation patents.

Another type is the recently arrived Belt Ice Corporation machine mentioned in the paper, concerning which little commercial information has been made public.

The fourth method of dislodging the ice is by heating the surface on which the ice has just been frozen. The heat may be provided in any of several ways. This principle is used in the Vogt "Tube-Ice" machine and in the York "automatic cube ice maker."

The fifth method proposed is the object of the present paper and as details are given therein, further mention is hardly necessary at this time.

It is noted that the author has introduced the excellent term "incremental film" principle. In other machines which the writer has made, embodying the freezing of thin films of ice and building them into a layer mass, he has used another term, that of "laminae freezer." Inasmuch as these latter do not remove the ice from the freezing surface by extrusion, it is hardly necessary to deal with them at the present time.

In so far as a comparison of the extrusion process of ice making with the commercial cake and can ice is concerned, the writer is happy to concur with the author's conclusions. However, it may be somewhat unfortunate that opportunity has not been afforded for more detailed comparison of test data of the various types of small ice machines. In the present state of development, care must be taken not to compare machines operated under pilot-plant or semiplant conditions with data for full-scale operation, as the latter generally introduces certain features which render necessary the establishment of a factor of safety which may differ from the results of pilot-plant test runs. It is possible to take exception to some of the other statements of the author, principally because they are somewhat too general and may not be strictly accurate when applied to specific industries.

The use of over 15,000 tons per day of small ice manufactured prior to the advent of the machine described in the paper shows that there is a market for these other types of small ice. The writer would like to see each type of small ice take the markets for which it was specifically designed, as it is believed that the answer to the present sized ice being marketed by the ice manufacturers is "tailored ice," or "custom-built ice" designed to give the customer the most useful form of ice for his particular purpose.

Comment by Henry V. Heuser[10]

Those of us connected with the design and fabrication of the Vogt automatic "Tube-Ice" machine have been extremely interested in reviewing the work of the author. We believe he has contributed a great deal to the large amount of information available for solving the problem of producing ice more cheaply. His figures on current consumption per unit of ice manufactured are particularly interesting. Although certain improvements could be made in the economy of the machine by producing a commercial unit, it is our belief that the "Tube-Ice" method of manufacture, that is, the releasing of the ice by a momentary thaw, will produce more cheaply an equal weight of ice than can be made by employing the principle of releasing the ice by hydraulic pressure.

The author's experiments in the freezing of fruit juices for shipment and delivery have been aimed at containing all of the original liquid and the pulp in the frozen product and eliminating segregation. In the "Tube-Ice" machine our primary quest along this line has been toward the concentration of juices by freezing out the water. The technique for doing this has been advanced materially through the development of a freezer which will eliminate the necessity for thawing water to release the tube of ice from the lower tube sheet. Work on this concentrating problem is progressing, but no data are available to report at this time.

[10] Vice-President, Henry Vogt Machine Company, Louisville, Ky. Mem. ASME.

Comment by F. W. Knowles[11]

This novel and interesting development was called to the writer's attention by the author and inventor, in 1945. Its development since then has been observed with a great deal of interest.

The advantages of such a system are well set forth in the paper. We can enumerate what we believe to be the disadvantages of such an ice-making method, then if the favorable factors outweigh the unfavorable ones the plant theoretically should be acceptable for practical applications.

The writer has had access to a good many of the author's articles on ice extrusion and has watched a 1-ton extruder operate for a short period. The apparent disadvantages of the machine are as follows:

Excessive ram pressure to break the ice loose from the freezing surface; somewhat over 500 psi in the model inspected. It would be expected that this pressure, required to free the column of ice from the freezing surface, would increase with corrosion and wear or denting of the freezing surface.

Part of the ice does not always break clear of the freezing surface, a condition that would naturally reduce the freezing rate.

The cost of making ice in this system given as $1 per ton is entirely reasonable. To this, however, must be added the cost of cutting, judged to be 50 cents per ton; conveying and storage, which

[11] Manager, The Belt Ice Corporation, Seattle, Wash.

in the case of can ice averages 65 cents, or $2.15 per ton of ice in storage; removal from storage and crushing or breaking, an additional $1 per ton; or a direct cost of $3.15 per ton delivered to the dock, which is comparable in cost to ice produced in a good can-type plant.

White ice, not a particular disadvantage for railroad icing but not readily accepted elsewhere, as the entrained air increases the melting rate and the appearance where used on vegetables or other food products, is not particularly pleasing. Clarification of the extruded ice is impossible except with distilled water, not a likely method for modern use.

It seems that repairs to ram and pump would be somewhat high, due to the intermittent load and excessive pressure generated at the time of rupture.

It is doubtful if ice-plant owners on replacement would be interested in a system that would make ice of lower quality than the present can plant, or would wish to have a small unit in operation for each ton of ice produced when many tons are required daily.

COMMENT BY W. R. WOOLRICH[12]

In Great Britain and Northern Europe, block-ice manufacture is confined to a very few centers. The season for marketing ice to home users is too short to attract capital to invest in such a short season demand. Even in a densely populated center like London, the chances of a resident finding a supplier of retail block ice is very remote and until the advent of the electric and gas household refrigerators most residents had to be content with a cool pantry for meats and plate foods and a water bath for the bottled milk. Furthermore, today only a small percentage of homemakers have modern refrigeration in Great Britain.

Since Europeans are changing their diets to include more perishable foods such as milk, fish, fruits, and green vegetables, the need for crushed ice for the markets and transport vehicles of fresh foods is increasing. The prevailing very high price of mechanical refrigerators in all northern Europe and Great Britain affords an opportunity for the makers of machine ice to furnish a much-needed service to hundreds of suppliers and merchants of perishable foods in this great area. A machine constructed on the author's patent principle if built of reliable and simple design and construction can fill an economic need in many parts of the earth where ice is needed in small tonnages.

Commercial attempts to make ice by processes other than by immersing cans of water into a refrigerated brine date back three quarters of a century. Daniel Livingston Holden, who had probably contributed more to the early development of manufacturing ice in cans in brine than any other American, became convinced that he could supply ice more economically by methods involving higher rates of heat transfer. He set up a plant for manufacturing the Holden patent ice makers in the Philadelphia area and succeeded in distributing a few machines, but as a business venture his enterprise was a failure and it was closed.

Like the fate of many other industrial inventions, the economic factor most responsible for bringing about the failure of the Holden venture was that he was ahead of his time by several decades. The ice market of the period was for block ice that had an equivalent clearness to the best lake ice, and distilled water frozen in cans and, subsequently, agitated clear raw-water ice frozen in cans most satisfactorily met this requirement.

The modern demand for ice is much different from that of even three or four decades ago. While these early needs were primarily related to block-icing of home and store refrigerators and to refrigerator-car cooling, an analysis of the ice production of 52,960,000 tons in 1947, of the National Association of Ice Industries indicates that 1,433,400 tons were furnished as crushed ice, 849,200 tons were sold as ice cubes, and 1,705,150 tons retailed as sized ice. These three forms had an over-all increase of 1,450,800 tons, compared with the year 1945, which had approximately a production equal of all forms of ice made in 1947. The postwar trend is definitely to ice to be delivered in smaller forms.

The first man to meet successfully the commercial needs of machine-made ice was Col. Crosby Field. In his development of the Flakice machines of 1923, against great resistance of both a buying public and later with both a hostile NRA and depression years, he persevered and won. His machines are to be found today in the four corners of the earth, successfully operating in both small and large tonnages and as such, bespeak a real pioneering contribution to the ice-producing industry.

Since Col. Field successfully broke through the united opposition to machine-made ice, many have attempted to improve upon the method of production. The designs, which have been successful competitively, have each had special fields of application for which they were particularly suited.

The machine recently developed by the author has an admirable feature in that it can be made to produce cylinders or square blocks of either small or large cross section, and even the machine for the large-dimension blocks occupies a very small area and requires very little auxiliary equipment. It should find fields of usefulness in hotels, dairies, steamships, ranches, ice-cream plants, vegetable farms, and in many isolated plantations and enterprises located in the tropical and semitropical zones of Africa, Latin America, South Asia, and the Pacific Isles, as well as the United States and Europe.

COMMENT BY J. M. LEBEAUX[13]

Today, continuous processes are steadily supplanting batch processes in most phases of the manufacturing industry.

It is interesting to note these changes have not entered the cake-ice-manufacturing industry. This development by the author is therefore in line with the recent trends in technical progress. Here a machine has been perfected that will manufacture ice suitable for refrigerator cars, air conditioning, fishing boats, and other uses in which its appearance is not as important as price.

Other uses for this process undoubtedly will occur in those industries where a rapid congealing of a fluid is desired. Certainly, there must be many applications where the author's "incremental film" process may be used to bring about hardening.

Present-day ice plants seem to be facing steadily growing labor and other costs, such as the replacement of ice cans, brine coils, etc. The author's extrusion process may be the economical answer to some of these problems.

AUTHOR'S CLOSURE

The author thanks Profs. L. H. Bartlett and J. M. Lebeaux, Col. Crosby Field, Mr. Henry V. Heuser, Mr. F. W. Knowles, and Dean W. R. Woolrich for their generous comments. The author acknowledges special indebtedness to Professor Bartlett and Dean Woolrich for making possible the original experiments from which developed the extrusion ice-making process.

Professor Bartlett asks about ice adhesion to different surfaces. This process reveals little variance, probably because the taper of the extrusion cylinders dominates the purely surface

[12] The Foreign Service of the United States, American Embassy, London, England. Fellow ASME.

[13] Assistant Professor, Department of Petroleum Engineering, The University of Texas, Austin, Tex.

effects. However, the work of shearing the ice from the steel is comparatively small. The ram force acts through an infinitesimal distance and consumes only 0.20 kw per hr in the present machine. The other 0.60 kw per hr represents idle running between strokes. Multiple-cylinder extrusion machines will escape this waste, their hydraulic power load probably not exceeding 5 per cent of the total.

Aside from his patent, Dr. Josef Huber's experiments in Germany remain obscure. Probably they have been abandoned, and the author has been unable to ascertain their degree of success.

Mr. Knowles, manufacturer of belt ice machines, asks about the shearing load. No difficulties are anticipated here, for the hydraulic pressures used do not exceed those in many machine tools, trucks, tractors, excavating machines, and aircraft.

Mr. Knowles figures exaggerate the cost of extrusion-process cutting and handling. Cutting is automatic as cakes emerge from the machine day and night without human aid. Extrusion machines located above the storage vaults may obviate much stacking labor, while the high freezing rates may reduce the need for volume storage. Extrusion machines allow large users of ice to manufacture it in waste space for less than ice-plant cost. Projected designs will make 20 tons daily of 300-lb cakes from floor space of 7 ft × 14 ft.

Colonel Field, inventor of Flakice machines, has enumerated automatic ice-making processes now on the market. A 1948 newcomer, Dessard-Lees Company, Seattle, making flake-ice and ice-cube equipment, brings the number to six. All make "small" or "sized" ice at remarkable savings; it is unfortunate that this ice is unsuited for present refrigerated-food transport and for seasonal storage; however, almost all other phases of the food industry gain from its use.

Dean Woolrich underlines the foreign need for ice; apparently only the United States has near adequate supply, and to date 49 sources in 24 foreign nations have inquired about extrusion equipment. Export of extrusion ice machines is aided by lightweight (estimated at 1 ton per ton capacity) and low volume.

The American trend toward iced drinks creates the "sized" ice market. A similar trend toward year round consumption of fresh fruit, vegetables, meat, and fish sustains the block-ice market, for which extrusion-process ice is suitable.

J. R. WATT.[14]

[14] Assistant Professor of Mechanical Engineering, The University of Texas, Austin, Tex. Jun. ASME.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

NACA Annual Report

TWENTY-NINTH ANNUAL REPORT OF THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS, including 1943 Technical Reports Numbers 752 to 773. Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., 1948. Buckram, $8^3/_4 \times 11^1/_2$ in., figs., tables, illus., graphs, bibliographies, iv and 446 pp., $3.25.

REVIEWED BY F. K. TEICHMANN[1]

AFTER a hiatus of more than five years, the annual reports of the National Advisory Committee for Aeronautics are once more being published. The twenty-ninth annual report covers the fiscal year 1943, and includes Technical Reports Nos. 752–773, inclusive.

During 1943 the Committee's research effort was directed toward increasing the military effectiveness of America's aeronautical weapons. The first research project at the new aircraft-engine-research laboratory at Cleveland, Ohio, had begun operation, new high-speed wind tunnels were under construction at Langley and Moffett Fields, while the addition of a nine-inch supersonic wind tunnel permitted extension of the experimental program in supersonic aerodynamics.

The reports cover (1) a new method for calculating the potential flow past a body of revolution, based essentially on the fact that the form of the differential equation for the velocity potential is invariant with regard to conformal transformations in a meridian plane; (2) the methods used in the NACA tank for the investigations of the longitudinal stability characteristics of flying-boat models with special reference to determining suitable methods for evaluating the stability characteristics of flying-boat models, and determining the design parameters having an important effect on the proposing; (3) the operating temperatures of a sodium-cooled exhaust valve as measured by a thermocouple; (4) requirements for satisfactory flying qualities of airplanes; (5) the induction of water to the inlet air as a means of internal cooling in aircraft engine cylinders; (6) the measurement of fuel-air ratio by analysis of the oxidized exhaust gas; (7) performance of NACA eight stage axial-flow compressor designed on the basis of airfoil theory; (8) derivation of charts for determining the horizontal tail-load variation with any elevator motion; (9) a method of estimating the knock rating of hydrocarbon fuel blends; (10) identification of knock in NACA high-speed photographs of combustion in a spark-ignition engine; (11) a theoretical investigation of the lateral oscillations of an airplane with free rudder with special reference to the effect of friction; (12) tests of airfoils designed to delay the compressibility burble; (13) a method for calculating heat-transfer in the laminar-flow region of bodies; (14) exhaust-stack nozzle area and shape for individual cylinder exhaust-gas jet-propulsion system; (15) aerodynamic and hydrodynamic tests of a family of models of flying-boat hulls derived from a streamline body of NACA 84 series; (16) the problem of longitudinal stability and control at high speeds; (17) the flow of a compressible fluid past a curved surface; (18) the effect of mass distribution on the lateral stability and control characteristics of an airplane as determined by tests on a model in the free-flight tunnel; (19) jet boundary corrections for reflection plane models in rectangular wind tunnels; (20) review of flight tests of NACA *C* and *D* cowlings on the XP-42 airplane;

[1] Chairman, Department of Aeronautical Engineering, Daniel Guggenheim School of Aeronautics, New York University, New York, N. Y. Mem. ASME.

(21) determination of general relations for the behavior of turbulent boundary layers; (22) analysis of heat and compressibility effects in internal-flow systems and high-speed tests of a ram-jet system.

These titles give an indication of the wide range of subjects that came within the purview of the NACA in just one year.

Patent Law

Patent Law for Lawyers, Students, Chemists, and Engineers. By C. H. Biesterfeld. John Wiley and Sons, Inc., New York, N. Y., Chapman and Hall, Ltd., London, England. Second edition, 1949. Cloth, $5^{1}/_{4} \times 9$ in., viii and 267 pp., \$4.

Reviewed by H. H. Snelling[2]

THE author of Patent Law for Lawyers, Students, Chemists, and Engineers has had wide experience in the examining corps of the United States Patent Office, in private practice, as lecturer on patent law at the University of Delaware, and as head of the patent department of du Pont. While he is recognized in the field of law relating to chemical patents as an authority in that line of work, a careful study of the volume, which is beautifully printed and is published at an attractively low price, indicates that in so far as engineers are concerned they would obtain desired information from the book only in case they were reasonably familiar with patent law or if they r ad the entire volume.

As an example of the relative appeal to student lawyers and to engineers we might note that there are over 18 pages of legal cases by name but less than 5 pages of subject index. The subject index itself is quite defective from our standpoint because an engineer would look for "Monopolies" under M and he would look for "Restraint of Trade" under R or T, but in vain. A patent lawyer, on the other hand, would quickly turn to D for "Defense" but even then would have to turn six pages, skipping "Preliminary Injunction," to find page 222 directed to the subject.

It is rather disconcerting to have a dissenting opinion cited without a definite note that it was such, for example, on page 162, even granting that we wholeheartedly agree with Justice Frankfurter. Incidentally, that decision and quite a few others are cited by United States Patent Quarterly volumes instead of by the United States volumes which could so much more readily be obtained by an engineer.

[2] Senior member, Snelling and Hendricks, Washington, D. C. Mem. ASME.

Although the book was published in February, 1949, references are made to the old numbers of the Patent Office Rules and in some cases refer definitely to a practice which is now obsolete, for example, near the bottom of page 129.

In spite of these disadvantages, if an engineer has some familiarity with patent law and already has a few books on the subject, the present volume would be a welcome addition to his library as the text is read with ease and the language simple and understandable.

Books Received in Library

Applications Physiques de la Transformation de Laplace. (B. Méthodes de Calcul 1.) By M. Parodi. C.N.R.S. editor (Centre National de la Recherche Scientifique), 1948; Dépositaire: Gauthier-Villars, 55 quai des Grands-Augustins, Paris (6e). Paper, $6 \times 9^{1}/_{2}$ in., 177 pp., diagrams, tables, 800 fr. Of interest to physicists and engineers, this book considers practical applications of the Laplace transformation and the symbolic calculus to the solution of differential equations, partial differential equations, definite integrals, and integral and integral-differential equations. The relationships of the symbolic calculus to the theory of Volterra and to electrical networks are discussed.

Centrifugal and Other Rotodynamic Pumps. By H. Addison. Chapman & Hall Ltd., London, England, 1948. Cloth, $5^{1}/_{2} \times 8^{3}/_{4}$ in., 492 pp., diagrams, charts, tables, 36s. This book deals, in a general way, with most of the questions likely to concern designers, makers, and users of centrifugal pumps and allied machinery. The text material is divided into four sections: principles; design and construction; performance; and installation. It covers the entire range of centrifugal, screw, and propeller pumps. Forty-eight worked-out examples of pump and pumping-plant problems are appended, with specific reference to the pertinent text paragraph.

Computation Curves for Compressible Fluid Problems. By C. L. Dailey and F. C. Wood. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, London, England, 1949. Paper, $9^{1}/_{4} \times 11^{1}/_{4}$ in., 33 pp., text, charts, \$2. Serving as supplementary material to the text, "Aerodynamics of a Compressible Fluid," by Liepmann and Puckett, this volume presents a series of charts in three sections: energy relations and heat addition functions; plane shock and expansion relations; and conical-flow relations—Taylor-Maccoll theory. A brief discussion is given of each function and its corresponding plot to explain its use.

Economics of Industrial Management. By W. Rautenstrauch and R. Villers. Funk & Wagnalls Company, New York, N. Y., 1949. Cloth, $6 \times 9^{1}/_{4}$ in., 451 pp., diagrams, charts, tables, \$5. With a view to practical use in all situations, this book applies the science of industrial economics to industrial engineering and accounting. Outstanding features are a detailed description of the latest developments of the Break-Even Chart process of analysis, a consideration of the fundamental principles involved in the study of industrial costs, and an analysis of the situation of business as part of the "National Plant" as a whole.

Elements of Mechanical Vibration. By C. R. Freberg and E. N. Kemler. Second edition. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, London, England, 1949. Cloth, $6 \times 9^{1}/_{4}$ in., 227 pp., illus., diagrams, charts, tables, \$3.75. Of interest to both students and engineers, this book is a practical elementary treatment of mechanical vibration, including the mobility method and the electrical analog. As in the previous edition, all problems are treated simply from a basic analysis. Two new chapters include material on sound and its engineering applications, and on beams.

Engineering of Organization and Management. By R. T. Livingston. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1949. Cloth, $6 \times 9^{1}/_{4}$ in., 247 pp., diagrams, charts, tables, \$3. This fundamental and practical book presents a philosophy of modern management approached as a complete theory, rather than as a specific application. It discusses in detail a function such as decision making, and then presents its point of maximum application. Outstanding chapters consider the necessity for understanding men, the theory of action, and the interlinked cycles of action.

Engineering the New Age. By J. J. O'Neill. Ives Washburn, Inc., New York, N. Y., 1949. Cloth, $5^{1}/_{4} \times 8^{1}/_{4}$ in., 320 pp., tables, \$3.50. This book presents the story of the individual and the role he will play in the unfolding of the new era in which all our resources are directed toward human welfare. It considers the relationship of man to the cosmos, man to man, and man to his community. It finds an underlying pattern which provides a blueprint for progress in accordance with the methods established by the engineer and scientist.

Fluid Mechanics. By R. C. Binder. Second edition. Prentice-Hall, Inc., New York, N. Y., 1949. Cloth, $6 \times 9^{1}/_{4}$ in., 361 pp., illus., diagrams, charts, tables, \$5.65. The aim of this book is to present an introduction to the fundamentals of fluid mechanics, keeping physical concepts and established quantitative relations in the foreground. Statics, kinematics, and dynamics are considered, followed by discussions of viscosity, dimensional analysis, and dynamic similarity. Instruments, hydraulic machinery, and particular cases of flow are then treated. Each chapter is followed by a list of selected references and numerous problems.

Grundzüge der Tensorrechnung in Analytischer Darstellung. (Teil I, Tensoralgebra.) By A. Duschek and A. Hochrainer. Second edition. Springer-Verlag, Vienna, Austria, 1948. Paper, $5^{1}/_{2} \times 8^{1}/_{4}$ in., 129 pp., diagrams, tables, \$2.70. The first part of a book on tensor analysis presents the basic principles and fundamentals of tensor algebra. It is of interest not only to mathematicians and physicists, but to technicians in industrial research and computation departments as well. A knowledge of college mathematics is assumed.

How to Keep Invention Records. By H. A. Toulmin, Jr. Research Press, Dayton, Ohio, 1948. Cloth, $5^{1}/_{4} \times 8$ in., 78 pp., tables, \$2.50. Dealing with the measures necessary to protect patentable material, the first part discusses the general nature of industrial property and monopolies granted to protect it. In the second part, a practical method

of insuring the recording of dates is presented in a series of a dozen forms. A final chapter deals with the methods of patent investigation.

LES LAITIERS MÉTALLURGIQUES ET LEURS RÉACTIONS. By E. Eyt, preface by P. Chevenard. Dunod, Paris, France, 1949. Paper 6 × 9¼ in., 94 pp., diagrams, charts, tables, 960 fr. Of interest to those concerned with the actions of slags in the production of steel. The first part considers chemical equilibrium, reactions, and activity. The second and third parts are concerned with acid and basic slags. In the fourth part there is a study of silica equilibrium and an explanation of the mechanism of the deoxidation of steel.

METAL WORKING AND HEAT-TREATMENT MANUAL, volume 3. Surface Hardening Processes. By F. Johnson. Paul Elek Publishers Ltd., Diamond House, London, E.C.1, England, 1948. Cloth, 5½ × 8¾ in., 185 pp., illus., diagrams, charts, tables, 17s, 6d. Written primarily for the engineer and the student of engineering, this third volume of a four-volume set considers metal surface-hardening processes. Carburizing, cyaniding, nitriding, flame hardening, and induction hardening are discussed in detail. Three methods of surface protection during heat-treatment are described. Many tables and diagrams illustrate the text.

METALLURGY AND MAGNETISM. By J. K. Stanley. American Society for Metals, Cleveland, Ohio, 1949. Cloth, 6 × 9¼ in., 156 pp., illus., diagrams, charts, tables, $4. Based on lectures given at the Thirtieth National Metal Congress, this book points out the relation existing between the fields of metallurgy and magnetism. It considers magnetic theory, a classification of magnetic materials, factors affecting magnetic properties, and magnetic analysis as a metallurgical tool. Numerous references are given so that the interested reader can pursue the subject further.

PRINCIPLES OF MECHANICS. By J. L. Synge and B. A. Griffith. Second edition. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1949. Cloth, 6 × 9¼ in., 530 pp., diagrams, charts, tables, $5. This volume is a text for intermediate courses in mathematics, physics, and engineering-mechanics departments. The principal revision of this second edition occurs in the rewriting of the account of the motion of a charged particle in an electromagnetic field. Other changes include an amplification of the treatment of principal axes of inertia, and revisions in the material on Foucault's pendulum, the spinning projectile, and the gyrocompass. The emphasis on units and dimensions has been increased. A few additional exercises have been inserted, and numerous minor corrections made.

PROPERTIES OF SOFT SOLDERS AND SOLDERED JOINTS. (Research Monograph No. 5.) By J. McKeown, with a foreword by H. Moore. British Non-Ferrous Metals Research Association, London, N.W.1, England, 1948. Cloth, 6 × 10 in., 118 pp., illus., diagrams, charts, tables, 17s, 6d; $4. This monograph describes the work carried out and the results obtained in a wartime research on solders of varying composition. The section on soldering power tests includes bit-soldering, area of spread, and capillary penetration tests. The section on mechanical properties covers bulk solders, hot tearing, and creep and fatigue tests on soldered joints.

ROCKET DEVELOPMENT, Liquid-Fuel Rocket Research, 1929–1941. By R. H. Goddard, edited by E. C. Goddard and G. E. Pendray. Prentice-Hall, Inc., New York, N. Y., 1948. Cloth, 6 × 9¼ in., 291 pp., illus., diagrams, tables, $6.50; text edition, $4.90. Of interest to engineers in rockets and jet propulsion, this book presents the Goddard data on experiments performed from 1929 until 1941. They comprise the entire Goddard rocket development from the first liquid-fuel-rocket flight until the beginning of World War II.

SLEEVE BEARING MATERIALS. By R. W. Dayton and others. American Society for Metals, Cleveland, Ohio, 1949. Cloth, 6 × 9¼ in., 256 pp., illus., diagrams, charts, tables, $5. This series of papers, presented during the 28th National Metal Congress and Exposition, is grouped into four parts. These are: (*a*) the nature of bearing materials; (*b*) the types of bearing materials; (*c*) bearing structure and fabrication; and (*d*) the applications of bearings. Comment is added to state the subject and its background, and to give information not elsewhere expressed. Some eighteen papers, by specialists in the field, are included with technical discussion.

STATISTICAL YEAR-BOOK OF THE WORLD POWER CONFERENCE, No. 4. Data on Resources and Annual Statistics for 1936–1946, edited by F. Brown. World Power Conference, London, W.C.2, England, 1948. Cloth, 8½ × 11 in., 212 pp., tables, £2, 5s. This compilation contains statistics of the resources, production, stocks, imports, exports, and consumption of power and power sources in all the countries of the world for which it was possible to obtain information. The power sources included are coals, brown coal and lignite, peat, coke, manufactured fuel, wood, petroleum, benzoles, alcohols, natural gas, manufactured gas, water power, and electricity. Most of the statistics were supplied by government organizations in the countries concerned and conform to standard definitions which are reproduced in the text.

TABLES OF SCATTERING FUNCTIONS FOR SPHERICAL PARTICLES. (Applied Mathematics Series 4.) U. S. Bureau of Standards, for sale by Superintendent of Documents, Government Printing Office, Washington, D. C. Paper, 8 × 10¼ in., 1948, 119 pp., tables, 45 cents. These tables of intensities, prepared by the Computation Laboratory of the National Applied Mathematics Laboratories, are based on the theory set forth by Gustav Mie. Intensity functions, noted in the introduction, give the angular distribution of intensity and the total light scattered by a small spherical particle as a function of a certain parameter. These factors can be used to determine particle size and concentration as explained in the introduction and by the use of the tables. An extension of the tables (Part 4) provide values for a problem in the application of microwave radar.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

TOLERANZEN UND LEHREN. By P. Leinweber. Fifth edition. Springer-Verlag, Berlin, Göttingen, Heidelberg, Germany, 1948. Paper, 6¼ × 9½ in., 138 pp., illus., diagrams, charts, tables, 8.40 DM. Following a brief statement of fundamentals, there is a discussion of the meaning, method of representation, and applicability of tolerances in the matter of dimensions, shapes, or surfaces. Section 3 describes a wide variety of gages and gaging methods, with notes on likely faults or errors. There is a bibliography.

WASTE-HEAT RECOVERY FROM INDUSTRIAL FURNACES. Institute of Fuel, London; Chapman & Hall, Ltd., London, England, 1948. Cloth, 5½ × 8¾ in., 384 pp., illus., diagrams, charts, tables, 35s. Based on a series of papers presented to the Institute of Fuel, this book is devoted to the results of studies made on means whereby the heat leaving industrial furnaces in the flue gases may be recovered and made to perform useful work. Attention is focused on regenerators and recuperators and on boilers of the type which use the waste heat for raising steam. Much heat-transfer data are given.

WEAR AS APPLIED PARTICULARLY TO CYLINDERS AND PISTON RINGS. By F. P. Bundy, T. E. Eagan, and R. L. Boyer. Cooper-Bessemer Corporation, Mount Vernon, Ohio, 1948. Cloth, 6 × 9¼ in., 129 pp., illus., diagrams, charts, tables, $3.50. Based on research and development work, this book presents in the first section the basic theory of friction and wear and the results of various wear tests. The second part covers metallurgical considerations in wear resistance, and the third is devoted to design aspects of cylinder and piston-ring wear. There is a bibliography.

ASME BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code may communicate with the Committee Secretary, ASME, 29 West 39th St., New York 18, N. Y.

The procedure of the Committee in handling the Cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer

and simultaneously published in MECHANICAL ENGINEERING.

Following is a record of the interpretation of this Committee formulated at the meeting of April 8, 1949, and approved by the Council on February 25, 1949.

CASE No. 994 (*Reopened*)

Inquiry: Will unfired pressure vessels fabricated by fusion welding under the requirements of Pars. U-69 and U-70 meet the intent of the Code if the base material is aluminum-manganese alloy conforming to Specification SB-178, Alloy M1?

Reply: It is the opinion of the Committee that aluminum-manganese alloy plate and sheets conforming to Specification SB-178, Alloy M1 may be used for the construction of unfired pressure vessels under the general requirements of Pars. U-69 and U-70. For vessels constructed under either of these paragraphs, the welding requirements of Par. U-69 and Section IX shall apply except that:

(1) The elongation as determined by the free-bend test shall be not less than 25 per cent;

(2) The rules of Par. U-20 shall be applied using the values in Table U-3 for annealed material for the allowable working stress multiplied by:

(*a*) For Par. U-69 construction, 80 per cent joint efficiency;

(*b*) For Par. U-70 construction, the ratio of *SE* values given in Par. U-70(**a**) divided by 11,000.

(3) Stress relieving is not required and is considered undesirable.

(4) The tensile strength of a reduced-section tension specimen shall be not less than 85 per cent of the minimum specified tensile strength of quarter-hard or as-rolled plate and not less than 95 per cent of the minimum specified tensile strength of annealed plate.

CASE No. 1082 (*Reopened*)

[*Interpretation of Par. P-115(a)*]

Inquiry: May inwardly flanged tube sheets be attached to shells in fire-tube boilers by fillet welding?

Reply: It is the opinion of the Committee that fire-tube boilers may be constructed by inserting the inwardly flanged tube sheet in the shell, attaching it thereto by fillet welding, provided that:

(1) The tube sheet is supported by tubes or braces, or both.

(2) The tube sheet is full fillet welded inside and outside.

(3) The shell at the welds is not in contact with primary furnace gases.

(4) The throats of the full fillet welds are equal to 0.7 of the thickness of the head.

(5) The constructions conforms in all other respects to Code requirements including welding, stress-relieving, etc., except that radiographing is not required.

(6) This construction shall not be used on rear head of a horizontal return-tubular boiler nor on a boiler with an extended shell.

(7) The length of flange shall conform to the requirements of Par. P-106 and the distance from the outside toe of of the outside fillet weld to the point of tangency of the knuckle radius shall be not less than $^1/_4$ in.

Errata

CASE No. 1078

On page 136 of the Interpretations, Case number at the end of the inquiry should be 896.

On page 140, revise the second, third, fourth, and fifth lines to read as follows: "form they shall be further machined by removing the lining material except $^1/_{16}$ in. to $^1/_8$ in. thickness and to a total thickness of $^3/_8$ in. . . . . ."

Proposed Revisions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code committee to receive and consider as promptly as possible any desired revisions of the rules and its Codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the Code, to be included later in the proper place.

The following proposed revisions have been approved for publication as proposed addenda to the Code. They are published herewith with corresponding paragraph numbers to identify their location in the various sections of the Code and are submitted for criticism and approval from anyone interested therein.

It is to be noted that a proposed revision of the Code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York 18, N. Y., in order that they may be presented to the Committee for consideration.

PAR. P-106. Revise to read as follows:

Dished heads concave to pressure to be attached by butt welding, and [backed-in] FLANGED heads or flanged furnace connections to be fillet welded, shall have a length of flange not less than 1 in. for heads not over 24 in. in external diameter and not less than $1^1/_2$ in. for heads over 24 in. in diameter.

PAR. P-186(**h**). Revise to read as follows:

Where the entire area OF A CIRCUMFERENTIAL JOINT is welded simultaneously [electric-resistance butt welding, or butt welding where thermit is employed as the heating element] UNDER PRESSURE without the introduction of extraneous metal [may be used and], the ultimate strength of the joint SHALL BE taken as 35,000 psi as in the case of forge welding. TYPICAL JOINTS IN THIS CLASSIFICATION ARE ELECTRIC-RESISTANCE BUTT WELDS, FLASH WELDS, AND JOINTS BROUGHT TO WELDING TEMPERATURE BY INDUCTION HEATING, CONTROLLED GAS FLAMES OR THERMIT.

Revise Table P-15 to read as follows:

TABLE P-15 MAXIMUM BOILER PRESSURES FOR USE OF AMERICAN STANDARD STEEL PIPE FLANGES, FITTINGS, AND VALVES

Adjusted Pressure Ratings for Carbon Steel Flanges and Flanged Fittings							
Type of joint	150	300	400	600	900	1500	2500
	Maximum allowable saturated-steam pressure at corresponding saturated-steam temperature						
Standard facing, 800 F	180	510	665	960	1360	2100	3100
Ring joint, 850 F	190	630	810	1160	1640	2500	3900
	Maximum allowable boiler pressure for feed line and blowoff line under this paragraph and Par. P-310						
Standard facing, 800 F	150	416	540	785	1120	1745	2625
Ring joint, 850 F	160	515	665	950	1350	2080	3120
Adjusted Pressure Ratings for Carbon Molybdenum and Low-Alloy Steel Flanges, Flanged Fittings, and Valves							
Type of joint	150	300	400	600	900	1500	2500
	Maximum allowable saturated steam pressure at corresponding saturated-steam temperature						
Standard facing, 900 F	...	510	665	960	1360	2100	3100
Ring joint, 950 F	...	630	810	1160	1640	2500	3900
	Maximum allowable boiler pressure for feed line and blowoff line under this paragraph and Par. P-310						
Standard facing, 900 F	...	416	540	785	1120	1745	2625
Ring joint, 950 F	...	515	665	950	1350	2080	3120

THE ENGINEERING PROFESSION

News and Notes

As Compiled and Edited by A. F. Bochenek

Labor-Management Co-Operation

IN SPITE of considerable doubt, the possibility exists that the trend to labor-management co-operation by American industry will grow sufficiently to exert a major influence on industrial relations, according to information brought to light by a recent survey conducted by the American Management Association, New York, N. Y.

The purpose of the two-year survey, "Greater Productivity Through Labor-Management Co-Operation," was to determine whether certain types of labor-management programs currently in use actually do arouse greater interest in output on the part of the individual employee and reduce friction in the day-to-day dealings with unions. To obtain information AMA used questionnaires and conducted 40 plant surveys in the field during which hundreds of production and personnel men, union officials, and individual employees were interviewed.

The type of co-operation studied was that engendered by the idea that it was to the common advantage of management and labor to raise productivity, and that only by increasing output could both wages and profits be increased without resorting to price increases. In practice the co-operation took the form of discussion groups composed of company and employee members, who met regularly to take up common problems. These meetings fell into three classifications according to their functions. Some groups limited their activities to gathering facts and exchanging information. Others met for the purpose of providing an opportunity to ask each other for advice on company or departmental problems. In some cases the groups proposed and discussed constructive actions. In few instances, however, did the co-operation programs provide for joint determinations except in minor matters. Generally the groups gathered facts, offered advice, and made suggestions to aid management in its function of management.

The principal findings of the AMA report follow:

1 Labor-management co-operation seems to be much more prevalent than it was a decade ago.

2 Co-operation's capacity to survive is considerable.

3 Where co-operation has been successful in unionized companies, it appears to have narrowed the field of disagreement between management and union.

4 Many companies, both unionized and nonunionized, claim that co-operation has resulted in improved employee attitude.

5 Co-operation is most heavily concentrated in medium-sized firms with from 500 to 5000 employees.

6 Co-operation appears to have a greater chance of success when started during periods of prosperity.

Beneficial Results

While the extent of co-operation was not wide, the report continues, the evidence of benefits achieved was impressive. "For example, the U. S. Steel Corporation and the United Steelworkers have engaged in what is probably the largest joint venture in job evaluation ever undertaken; 25,000 jobs were reduced to 30 classifications, and consistent rates established. Thousands of grievances and many work stoppages were eliminated in consequence.

"On the Illinois Central Railroad, the number of suggestions submitted by employees doubled, the number adopted trebled, after labor participation in promoting the suggestion system began. The Workmen's Safety Committee of the Colonial Beacon Oil Refinery helped reduce the number of injuries by more than 90 per cent over 18 years. The company had no disabling accidents in four of the last seven years. Some of the joint waste-reduction campaigns at the Westinghouse Electric Corporation led to a halving of defective work losses within a year or two."

Areas of Joint Effort

In some instances co-operation was on a departmental basis with emphasis on the individual, even though most of the companies were unionized and union stewards often served on the committees. Where group meetings were on a plant-wide basis, labor was generally represented by the union, if there was one, but the meetings were entirely separated from those devoted to collective bargaining. The report lists 22 areas of joint effort, among these being safety, waste, understanding company policies, quality control, methods improvement, labor turnover, utilization of machinery, promotional programs, and others.

Management's View

The managements of two thirds of the companies studied in the survey expressed themselves as "pleased" with the results of the co-operation. This was interpreted by the survey to mean that the co-operation had at least contributed to reduction of labor strife and the threat of strike when disagreement occurred, and created a more pleasant atmosphere even though this was no more than a "state of peaceful disagreement." Union officials also thought that co-operation helped to shift relationships with management from open warfare to peaceful disagreement.

On the other hand, the study revealed a good deal of opposition to formal co-operation on the part of both management and the unions. Some managements felt that since they were accountable for the success of their businesses, they could not afford to delegate any of their responsibility. In many cases union officials feared co-operation because it could undermine the major function of the union—the protection of the members.

Those favorably disposed to co-operation were of the opinion that most companies would be brought to consider co-operation only when it had been demonstrated that the practice could actually achieve competitive advantage. The possibility remains, the report concluded, that the trend to co-operation will continue.

Starting-Salary Trends

IN SPITE of the apparent general business lag and the upward trend of unemployment, January, 1949, graduates in science and engineering at Illinois Institute of Technology, Chicago, Ill., are drawing average monthly salaries of $15 more than the beginning pay of either the February, 1948, or June, 1948, classes.

The present figure of $280 for a basic 40-hour week is a new all-time high for a group of Illinois Tech graduates, John J. Schommer, director of placement, reports.

The February, 1948, class commanded starting wages of $265.25. The June, 1948, class averaged $264.72.

January, 1949, figures are based on reports from approximately 90 per cent of the graduating class. Illinois Tech awarded 306 bachelor's degrees in science and engineering at its winter commencement.

Civil engineers lead all other graduates with an average of $302, $22 per month more than in June, 1948, when they held second place. Chemical engineers fell from first to second place, although they increased their average from $283 to $285 per month.

Mechanical engineers are earning $283 a month which is also a jump of nearly $22 over the June, 1948, figure.

Starting salaries of other groups include:

Electrical engineers, $275; biology graduates, $275; business and economics graduates, $272; industrial engineers, $265; chemistry graduates, $255.

The entire class average of $280 is almost three times greater than the normal starting

pay of engineering and science graduates 11 years ago. In 1938 the average beginning wage was $100 a month.

Scientific Reconstruction

DURING 1948 UNESCO (United Nations Educational, Scientific, and Cultural Organization) purchased about a quarter of a million dollars' worth of scientific equipment for the war-devastated countries of Europe and Asia. In addition to this UNESCO has been asked to spend a quarter of a million dollars for Educational Reconstruction on behalf of the London Lord Mayor's Fund.

In 1949 a sum of $175,000 has been set aside by UNESCO for reconstruction of war-devastated countries. Of this sum, it is estimated that approximately 50 per cent will be spent on scientific equipment.

Credits will be allocated to various institutions in these countries for the purchase of scientific equipment, of their own choice, through UNESCO.

Engineers Honored at EJC Luncheon

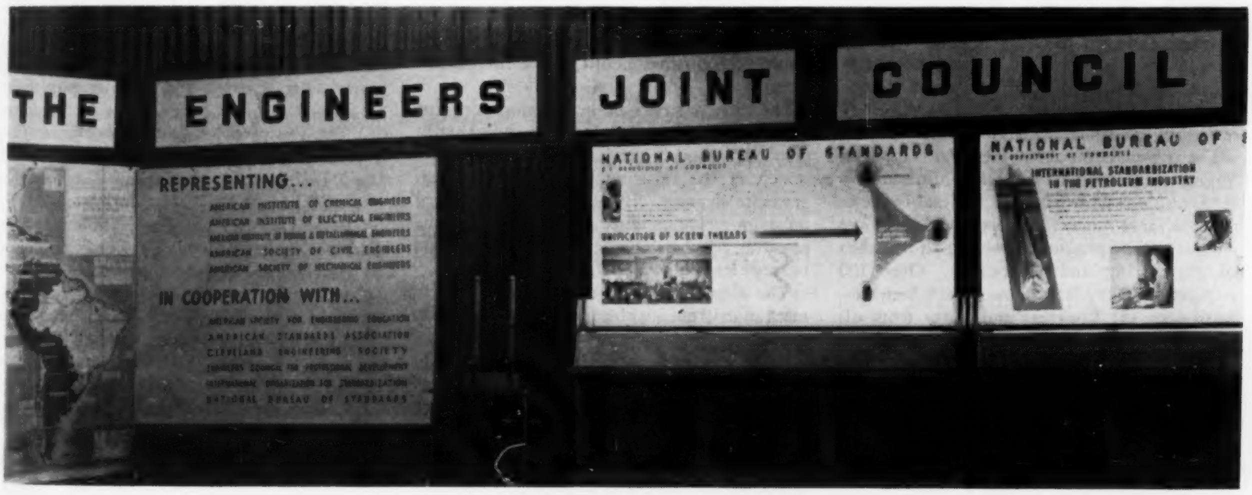
UNDER the auspices of the Engineers Joint Council, representatives of the Council, the Founder Societies, the American Institute of Physics, the American Institute of Chemical Engineers, the National Management Council, and The Engineering Foundation attended a luncheon at the Engineers' Club, New York, N. Y., on April 21, 1949, in honor of His Excellency, Gustavo Colonnetti, president,the Italian National Research Council, Rome, Italy; Dr. Giuseppe Gabrielli, chief engineer, FIAT, Turin, Italy; and Harold V. Coes, past-president ASME.

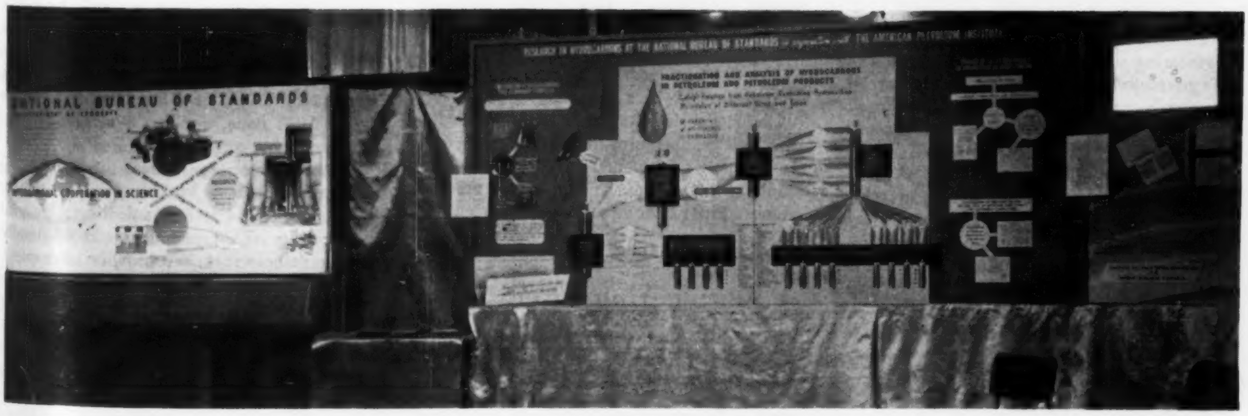
C. E. Davies, secretary ASME, presided. Dr. Colonnetti and Dr. Gabrielli brought greetings from their fellow engineers in Italy and expressed their appreciation of the opportunity afforded them of meeting engineers of this country. Both spoke in Italian, and their comments were ably translated into English by Prof. M. G. Salvadori, of Columbia University. Dr. P. Luigi Romita, of Milan, Italy, who was one of the guests and is in the United States to carry on research studies in hydraulics at the National Bureau of Standards, spoke briefly.

Mr. Davies then introduced Mr. Coes, who was leaving on May 4 to take a post as an ECA administrator in the Industry Division with headquarters at Paris. Mr. and Mrs. Coes will reside in Paris during the next 12 months.

Engineers' Week in New Jersey

APRIL 24-30, 1949, was observed as Engineers' Week in New Jersey. The observance was part of the 25th anniversary of the New Jersey Society of Professional Engineers. In a message to residents, Gov. Alfred E. Driscoll called attention to "the vital part engineering plays in their everyday lives." The high light of the week was the silver anniversary convention of the New Jersey Society of Professional Engineers in Newark, N. J.





ENGINEERING EXHIBITS AT THE SECOND NATIONAL CONFERENCE OF THE UNITED STATES NATIONAL COMMISSION FOR UNESCO HELD IN CLEVELAND, OHIO, MARCH 31–APRIL 2, 1949

(*Top:* Exhibits sponsored by the Engineers Joint Council. On the extreme left is a map of South America showing the points visited by Dean S. S. Steinberg on behalf of the EJC. On the right are displays describing the unification of screw-thread standards and international standardization of the petroleum industry. *Bottom:* Bureau of Standards exhibits, showing typical research projects which are benefiting international science. During the Conference, R. M. Gates, EJC representative on the National Commission, told how American engineers are fostering UNESCO objectives. For an account of the conference and a summary of Mr. Gates's remarks, see pages 379–380 of the May issue.)

First Pan-American Engineering Congress to Open in Rio de Janeiro

July 15-24, 1949

ENGINEERING societies and technical associations throughout the hemisphere will meet this summer in Rio de Janeiro, Brazil. The principal meeting will be in Rio de Janeiro and at the world-famous hotel of Quitandinha, about seventy miles outside of the city. Preceding this meeting, the Union of South American Engineers will have a week's meeting in Saõ Paulo. Although it is principally intended as a preliminary meeting for the Congress itself, North American engineers and visitors are invited to attend and to participate in it.

Representative groups of leading engineers in each country are co-operating on a hemispheric scale to make this meeting the largest and most successful of its kind. Although engineers from all the Latin American countries have met before, this is the first Congress to which engineers from the United States and Canada have been invited as active participants. The ultimate intention of this Congress is to create a pattern for succeeding meetings of a truly Pan-American character.

The organization of the First Pan-American Engineering Congress is being directed by F. Saturnino de Brito, Jr. Under his presidency a large number of papers and technical studies will be presented covering all branches of engineering and technology. Over 100 papers from the United States have been submitted to the Congress and range from all aspects of civil engineering, through mechanical, electrical, mining, metallurgical, management, and chemical engineering. Also being included for showing at the Congress are approximately 18 industrial films.

The First Pan-American Engineering Congress is planned as a prototype of meeting which will bring together the leaders and best expressions of thinking in all phases of engineering from each of the Americas. The inspiration for the Congress stems directly from the engineering societies themselves and not from any government or extraneous stimulation. In the words of the President of the Congress:

"Engineers in the Americas today need a 'town meeting' for the expression of common points of view, for the unification of plants, for the joint study of the great problems which confront it—problems which relate to the general welfare and to peace among nations—and for the achievement of personal contact and direct links among the engineers of the American community, for which nothing can substitute."

United States participation in the Congress was organized by the Committee for Participation in the Pan-American Engineering Congress of the Engineers Joint Council composed of the following: S. S. Steinberg, chairman, ASCE; E. A. Pratt, ASCE; Lloyd J. Hughlett, ASME; S. E. Reimel, ASME; Malcolm Pirnie, ASCE; R. M. Gates, ASME; and R. E. Dougherty, ASCE.

A considerable number of United States engineers and industrial leaders are planning on attending the Congress. Early estimates would seem to indicate that at least 40 of the authors of papers or their representatives will participate in the Saõ Paulo and Rio de Janeiro meetings. A cordial invitation is extended to all engineers to attend the meeting whether it be a part of their vacation trip to Brazil or in association with their business activities there.

Education

A NEW terminal degree for practicing engineers, to be called the "engineer" degree, has been approved at the Massachusetts Institute of Technology and is expected to be awarded for the first time at the Institute's commencement this month, it was announced recently.

The new degree will be recommended for students who complete an individually planned two-year program of study and research at the Institute beyond their undergraduate degrees. Emphasis will be placed on engineering practice rather than on the research which is characteristic of a program of study leading to a PhD degree.

The degree will be referred to as civil, mechanical, chemical engineer, according to the field of specialization.

WOMEN engineering students from 19 eastern colleges met at Drexel Institute of Technology, Philadelphia, Pa., April 2–3, 1949, and organized the first Society of Women Engineers to encompass more than a local group.

"We are a comparatively new group, we women engineers," Lillian M. Gilbreth, Fellow ASME, told the women engineering students, "and have a definite responsibility to see that there is for business or any job no disappointments because of us."

The new society has three types of membership, full memberships for women engineering students, associate memberships for women studying in related fields, and graduate memberships for women in industry.

Engineering Literature

ECPD 16th Annual Report

THE SIXTEENTH Annual Report of the Engineers Council for Professional Development covering activities during the year ending Sept. 30, 1948, is now available for distribution. The 40-page booklet contains the ECPD Charter and Rules of Procedure, reports of various ECPD committees and representatives of constituent societies in ECPD, Canons of Ethics for Engineers, financial statements, lists of accredited curriculums of engineering schools and technical institutions, and ECPD officers and committee personnel.

A feature of the annual report is a review of ECPD activities by J. W. Parker, chairman ECPD. According to Mr. Parker, the prime need of the ECPD is the participation of more engineers working on the community level who are better informed on ECPD objectives and progress. Mr. Parker's complete report appears on pages 23–25 of the January, 1949, issue of MECHANICAL ENGINEERING.

Copies of the report may be obtained from the ECPD, 29 West 39th Street, New York 18, N. Y., at 50 cents per copy.

Gas Turbines

SIX LECTURES on gas turbines presented before The Institution of Mechanical Engineers of Great Britain on Nov. 3–4, 1948, and published by IME as War Emergency Issue No. 41 "Internal-Combustion Turbines," has been reprinted by The American Society of Mechanical Engineers for distribution in the United States.

The six lectures with photographs, diagrams, charts, titles, and bibliography make up a booklet of 78 pages. The lectures are: (1) The Prospects of Land and Marine Gas Turbines, by Hayne Constant; (2) The Part-Load Performance of Various Gas-Turbine Engine Schemes, by D. H. Mallinson and W. G. E. Lewis; (3) The Fuel Problem in Gas Turbines, by Peter Lloyd; (4) The Performance of Axial-Flow Turbines, by D. G. Ainley; (5) Heat Flow in the Gas Turbine, by A. G. Smith; and (6) Three-dimensional-Flow Theories for Axial Compressors and Turbines, by A. D. S. Carter.

The booklet sells for $2.25 and may be obtained from the ASME Publication-Sales Dept., 29 West 39th Street, New York 18, N. Y.

Gear Engineering

ANOTHER standard recently published by the ASME is a revision to the American Standard, "Letter Symbols for Gear Engineering ASA B6.5–1949" which supersedes the original standard issued in 1945. The revision corrects a few errors in symbols called to notice in the 1943 issue, and has several additions which clarify typography.

The purpose of the standard is to establish a uniform practice in mathematical notations for equations and formulas dealing with gear engineering. The symbols are not intended for use in drawings, research, or correspondence. Their proper use is in the mathematical work in published articles, papers, and books to make understanding easier and confusion less likely.

Four lists of symbols are given. List 1 is composed of English alphabet letters; List 2 shows Greek letters which are used; List 3 recommends a plan for subscripts; and List 4 gives general and special symbols for gear engineering.

The standard was revised by the Sectional Committee on Standardization of Gears, sponsored by the American Gear Manufacturers Association and The American Society

of Mechanical Engineers. Copies of the 9-page standard may be obtained from the ASME Publication-Sales Dept., 29 West 39th Street, New York 18, N. Y. Price per copy is 40 cents.

Notes on Coming Meetings

Heat Transfer and Fluid Mechanics

THE 1949 Heat Transfer and Fluid Mechanics Institute will be held on the campus of the University of California, Berkeley, Calif., June 22–24. The Institute will consist of six sessions at which 23 papers will be presented on such subjects as interferometric studies of beginning turbulence in free and forced-convection boundary layers on a heated plate; heat-transfer coefficients and friction factors for air flowing in a tube at high surface temperatures; cooling by forcing a fluid through a porous plate in contact with a hot gas stream; cocurrent gas-liquid flow; boundary-layer effects on spinning spheres; method for measuring surface heat transfer using cyclic temperature variations, and others.

R. G. Folsom, Mem. ASME, division of mechanical engineering of the University of California, will make the opening address.

Arrangements have been made for housing accommodations in the University dormitories and are available on a fixed fee basis for the duration of the Institute. Advance registration is requested.

All papers presented at the Institute will be available in a Proceedings which will be published by The American Society of Mechanical Engineers. Copies may be ordered from the ASME Publication-Sales Department, 29 West 39th Street, New York, 18, N. Y., for $4 to ASME members and $5 to nonmembers.

People

G. J. Nicastro Elected President NYSSPE

AT THE annual meeting of the New York State Society of Professional Engineers, held on April 23, 1949, at the Hotel New Yorker, New York, N. Y., George J. Nicastro, Mem. ASME, was elected president. Mr. Nicastro is associated with Combustion Engineering-Superheater, Inc., New York, N. Y., as sales engineer.

He has been active in the National Society of Professional Engineers as vice-president, a past-president of its New York Chapter, and as a director and chairman of the Chapter Activities Committee of the National Society.

Mr. Nicastro has been active in the Metropolitan Section of The American Society of Mechanical Engineers for many years. In 1942 he was chairman of the Section. He is well known to many members as chairman for 12 years of the Metropolitan Section Education Committee, and is currently chairman of the

GEORGE J. NICASTRO, MEM. ASME, WHO WAS RECENTLY ELECTED PRESIDENT OF THE NEW YORK STATE SOCIETY OF PROFESSIONAL ENGINEERS

Management Division. Mr. Nicastro is a graduate of Stevens Institute of Technology.

ALBERT L. RUIZ, Mem. ASME, was the recipient of the Yale Engineering Association Award for Advancement of Basic and Applied Science for work done during World War II on bombsight, torpedo-director, and automatic-gunfire-control projects. He is currently engaged as engineer, Ordnance Applications, General Electric Company, Schenectady, N. Y.

LOUIS J. POWERS, Jun. ASME, was one of the six engineers selected by Tau Beta Pi for a graduate-fellowship award in 1949–1950. He is a mechanical-engineering graduate of Texas Technological College, 1939, where he is now a professor of mechanical engineering. He will take advanced work at the University of Texas for a master's degree.

JOHN L. FERTIG was named representative of The American Society of Mechanical Engineers to the inauguration of Dossie Marion Wiggins as the fifth president of the Texas Technological College which was held on Tuesday, May 2, 1949, in Lubbock, Texas.

HUGO DE HAAN, secretary general of the International Committee of Scientific Management, Geneva, Switzerland, was presented the Wallace Clark International Award by the National Management Council of the U. S. A. at an informal dinner meeting on May 17, 1949, held at the Hotel Statler, New York, N. Y.

CHARLES L. POPE, Mem. ASME, a lubrication engineer employed by Eastman Kodak Company, Rochester, N. Y., received two honors recently. He was elected president of the American Society of Lubrication Engineers at a meeting in the Hotel Statler, New York, N. Y. At the same time he was named the first recipient of the ASLE Alfred E. Hunt Memorial Medal.

The medal is awarded annually to the author of the "outstanding technical paper" published each year in *Lubrication Engineering*. Mr. Pope won the award for his 1948 paper on management's appraisal of lubrication engineering in which he outlined what is expected of engineers working in this special field.

CLARENCE E. KINNE, Mem. ASME, former president of Bagley and Sewell Company, with which firm he had been associated for forty-seven years until his retirement in 1940, was awarded a Fifty-Year Pin by ASME. He is recognized as one of the ranking paper-machine engineers. Presentation of the pin was made by Dr. L. K. Sillcox, executive vice-president, New York Air Brake Company, at the Kinne residence, on behalf of the Society. Dr. Sillcox is a Fellow ASME and ASME Medalist, 1943.

S. C. MASSARI, Mem. ASME, was awarded The John H. Whiting Gold Medal by the American Foundrymen's Society. Among the others to win awards were: Russell J. Anderson, The Peter L. Simpson Gold Medal; and G. Vennerholm, The William H. McFadden Gold Medal. In addition to the gold medals, honorary life membership in the society was awarded to Clement J. Freund, dean, School of Engineering, University of Detroit, Mem. ASME, Anthony Haswell, Ralph L. Lee, and W. B. Wallis.

H. J. GOUGH was recently elected president of The Institution of Mechanical Engineers of Great Britain. He was educated at the University College School and London University where he obtained an Honors Degree

Meetings of Other Societies

June 20–24
The American Society for Engineering Education, annual meeting, Rensselaer Polytechnic Institute, Troy, N. Y.

June 20–24
American Institute of Electrical Engineers, summer general meeting, New Ocean House, Swampscott, Mass.

July 13–15
American Society of Civil Engineers, summer convention, Hotel Del Prado, Mexico City, Mexico

Aug. 17–19
Society of Automotive Engineers, Inc., West Coast meeting, Hotel Multnomah, Portland, Ore.

Aug. 22–26
National Association of Power Engineers, Inc., national convention, Hotel Sherman, Chicago Ill.

Aug. 23–26
American Institute of Electrical Engineers, Pacific general meeting, Fairmont Hotel, San Francisco, Calif.

(*For ASME Calendar of Coming Events see page 537*)

in the Faculty of Engineering and, later, received the degree of doctor of science.

Dr. Gough has lectured before the leading technical societies and colleges in England and the United States, and has contributed greatly to the field of scientific literature.

In 1942 he was appointed director general of Scientific Research and Development of the Ministry of Supply. Since September, 1945, he has been the engineer in chief of Messrs. Lever Brothers and Unilever, Ltd. Among his wartime duties was that of chief liaison officer on Scientific Research and Development with the Allies; on Aug. 21, 1947, the United States Government decorated Dr. Gough with the Medal of Freedom, with Silver Palm.

WILLIS HAVILAND CARRIER, Hon. Mem. ASME; ASME Medalist, 1934, chairman emeritus of Carrier Corporation, was honored at a testimonial dinner in Syracuse, N. Y., April 13, 1949, by the North American Branch of the Newcomen Society of England as "the father of air conditioning." Leaders of industry, finance, commerce, and science from various parts of the United States and Canada were present. Cloud Wampler, president of Carrier Corporation, was the principal speaker.

The Newcomen Society is an organization which honors persons who have contributed or are contributing to the material progress of mankind.

R. B. MEARS, Carnegie-Illinois Steel Corporation, Pittsburgh, Pa., received the 1949 Willis Rodney Whitney Award of the National Association of Corrosion Engineers, and F. L. LaQue, International Nickel Company, Inc., New York, N. Y., received the 1949 Frank Newman Speller Award at the NACE annual banquet held at the Netherland Plaza Hotel, Cincinnati, Ohio, on April 13, 1949.

The awards, named after Willis Rodney Whitney, who was the first to receive the award in recognition of achievement in the field of corrosion science, and after Frank Newman Speller, the first to receive the award in recognition of achievement in the field of engineering, are made annually to the person voted best qualified in the two fields defined.

D. S. JACOBUS AND C. A. ADAMS SHARE HONORS WITH THEIR WIVES AT THE BOILER CODE COMMITTEE MEETING DINNER ON APRIL 7

(*Left to right:* Dr. Jacobus, E. G. Bailey, J. H. Deppeler, and C. A. Adams applaud Mrs. Jacobus and Mrs. Adams who rose to acknowledge the tribute.)

ASME Honors D. S. Jacobus and C. A. Adams

THE Boiler Code Committee of The American Society of Mechanical Engineers honored two of its distinguished members, D. S. Jacobus and C. A. Adams, at a testimonial dinner on April 7, 1949, at the Astor Hotel, New York, N. Y. More than 85 members of the main committee and its subcommittee, with their wives, were present.

E. G. Bailey, Fellow and past-president ASME, presented to Dr. Jacobus and Dr. Adams a special scroll signed by their associates in recognition of their contributions to the committee and The American Society of Mechanical Engineers.

Speaking for the ASME, C. E. Davies, secretary ASME, called the occasion epoch-making in the history of the Society. "Tonight," he said, "the Boiler Code Committee and the Society are paying tribute to two men who have made one of the most important contributions to our work that I think has ever been made. I think of the ASME stamp on a boiler as a mark of integrity, of honesty of mind, of objectivity of viewpoint, and to me the gentlemen we are here to honor tonight typify those three qualities, without which the Boiler Code cannot continue."

Among the associates who paid tribute to the two men were E. G. Bailey, J. H. Deppeler, C. O. Myers, C. W. Obert, H. LeRoy Whitney, W. H. Boehm, and A. G. Pratt.

Dr. Adams joined the ASME in 1917 and became a member of the Boiler Code Committee in 1934. In addition to serving on the Main Committee, he has been a member of the Subcommittee on Unfired Pressure Vessels, and Committee on Welding. He has been chairman of special committees on radiographic examinations of welded joints, alloyed and high-tensile steels for welded pressure vessels, and approval of new materials.

For nearly 50 years Dr. Adams taught at Harvard University and was a consultant on high-frequency induction heating, welding, and gas explosions. After serving on the National Research Council in various capacities during World War I, he organized the American Welding Society and became its first president. Dr. Adams was also one of the founders and the first chairman of the American Engineering Societies Standards Committee, which is now the American Standards Association.

Dr. Jacobus is perhaps the only living member of the ASME who was present at the organization meeting of the ASME held in Stevens Institute of Technology in 1880. He became a member in 1889 and served as president in 1916. He began his boiler-code work in 1914 as member of an advisory committee, and later became a member of the main committee. From 1917 to 1947 he was chairman of the Executive Committee, and from 1936 to 1941 chairman of the Main Committee. Dr. Jacobus helped to draft the Co-Ordinate Marine Boiler Rules, which were adopted by the Bureau of Navigation and Steamboat Inspection in 1935. He also helped to prepare the joint API-ASME Code for Pressure Vessels.

After graduating from Stevens Institute of Technology in 1884, Dr. Jacobus remained at the Institute to teach and to earn for himself an international reputation as a test engineer of power equipment. Before his retirement he was a consultant to the Babcock and Wilcox Company, New York, N. Y.

E. A. Uehling, Oldest Member of ASME, Talks of Career

ON June 3, 1949, Edward A. Uehling, Mem. ASME, reached his one hundredth birthday and looked back on an engineering career which antedates The American Society of Mechanical Engineers by three years. A student under Prof. Robert Henry Thurston, first president of the ASME, Dr. Uehling graduated from Stevens Institute of Technology in 1877 and served for more than a year as Professor Thurston's assistant in research on the properties of cold-rolled steel.

A resident of West Allis, Wis., since his retirement 30 years ago, Dr. Uehling delighted old friends in the ASME by attending a luncheon at the 1948 Semi-Annual Meeting in Milwaukee. Later that day he was awarded a

65-year membership certificate in recognition of his contributions to the engineering profession which include invention of a recording pyrometer and a pig-iron casting machine.

Dr. Uehling wears a thin long white beard which rests on his chest, and has twinkling eyes and a ready wit. Years ago he explained his beard as a flag of identification which permitted his friends to recognize him in a crowd a half a block away. They could act accordingly—either dash up an alley or advance to greet him. Last year he admitted, however, that it was dislike for the barber chair that has kept the razor away from his chin for 50 or 60 years. But even the beard does not help to make him look his age. He looks more like a man of 70 or 75.

Five years ago he attributed his physical and mental vigor to a strong constitution and an unexcitable temperament. "If you want to live long, don't worry. Don't bid the devil good morning before he comes. Do all things in moderation . . . . . But above all, do not worry," he said.

Dr. Uehling lives with his son and daughter-in-law and devotes much of his time to writing essays on current topics which he distributes among his grandchildren. Some of his essays cover militarism, human nature, and the atom bomb.

When asked recently about his experiences as a young engineer, he responded with the following autobiographical essay:

Engineering Degree a Handicap

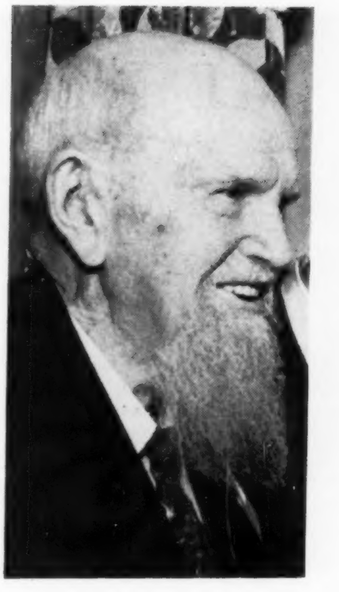
I graduated from the Stevens Institute in June, 1877. Assistant to Prof. Robert Henry Thurston in an investigation of the properties of cold-rolled iron and other tasks until October, 1878. In those days the majority of the superintendents and foremen of manufacturing plants had worked their way up to their positions the practical way. They did not favor young men with an ME to their name. Finding no position I went home to the farm where I could at least earn my board until I found professional employment.

In March, 1879, I received a letter from my classmate, James Pierce, in Sharpsville, Pa., saying, "We are starting a rolling mill and I am sure there will be a position there for you; come right on." Alas, when I got there, the position Jim had intended for me was given to the son-in-law of the superintendent, which left me stranded.

Dollar a Day

There were eight blast furnaces in Sharpsville, of which the Pierce family owned five. They also owned coal mines and a railroad connecting the mines with their furnaces. When the latter offered me the position of head chainman at a dollar a day, I accepted. Although quite a comedown from twenty-five cents an hour that Professor Thurston paid me, it was in the engineering line, and since I paid only five dollars a week for board and lodging, it got me out of the red. Everything was cheap in those days.

My next job was draftsman for the Douglas Furnace Company at Sharpsville, remodeling one of their furnaces at one dollar and a half a day, a fifty per cent increase. Then assistant to the superintendent at fifty dollars a month which was not only an appreciable boost in



DR. E. A. UEHLING, MEM. ASME, WHO REACHED HIS 100TH BIRTHDAY THIS MONTH

pay, but it also gave me an opportunity to learn a lot about the construction and operation of a blast furnace.

The furnace companies in Sharpsville were badly in need of a chemist. To satisfy that need I took a six-weeks' course in analytical chemistry, started a laboratory, and did well enough to get married. In the course of time I was offered and accepted the position of chemist for the Bethlehem Iron Company at a salary more than double the profit my laboratory was yielding.

I went into chemistry as a steppingstone toward a higher position in the field of metallurgy of iron. I was, therefore, glad to accept the offer of superintendent of one of the furnaces of the Sharpsville Furnace Company at a salary twenty-five per cent less than I was receiving as a chemist. After operating the furnace one and a half years with probably better than average success, the Bethlehem Iron Company offered me the superintendency of their five furnaces at a salary nearly double that I was then receiving. Two years later the Sloss Iron and Steel Company in Birmingham, Ala., offered me a much higher salary than I was receiving, to take charge of their four blast furnaces. Thus I had the good fortune to rise from the very lowest to the highest remuneration in those days for the services I rendered.

Blast-Furnace Developments

During the 15 years from 1880 to 1895 that I was active in the blast-furnace field, the height of blast-furnaces was increased from 50 to 70 ft, the blowing power was increased proportionately which increased the average output from 50 to 150 tons per day. This created a major problem as to how to handle these continually increasing outputs. During this period regenerative hot-blast stoves also displaced the iron-pipe stoves and increased the blast temperature from an average of 700 to 1200 deg. This created a minor, but very urgent, problem of producing a pyrometer to indicate and, if possible, also to record these higher blast temperatures. It was my good fortune to solve both problems and I started a shop in Newark, N. J., to supply the demand. The pneumatic pyrometer both indicated and recorded temperatures up to 2500 deg.

The practicability of the casting machine was in doubt, but the need of it was such that the Carnegie Steel Company risked $15,000 to build the first machine. Its complete success induced other inventors to design and find backers to build several casting machines, all of which infringed to greater or lesser extent on my patent. To avoid lawsuits the Carnegie Steel Company formed the American Casting Machine Company, and for having taken the risk of the possible failure of the machine, Mr. Carnegie exacted 51 per cent of the stock and a license for all the blast furnaces of the Carnegie Steel Company.

European Experience

The casting machine attracted the attention of the English and German ironmasters, which resulted in forming the Uehling Company in England. After the pyrometer shop, which later became the Uehling Instrument Company, was established, I went to England to serve as chief engineer for the Uehling Company. During the two and one half years that I was active there, we installed casting machines at all the chief blast-furnace plants in Germany, two in Austria, but only one in England. Labor was cheap there and the output of the furnaces not too large to be handled by manual labor. On the other hand, we equipped the majority of the English furnaces with the Uehling pyrometer, but only two in Germany. They preferred the electric pyrometer because it was much cheaper, but did not record.

I came back to the United States in 1901 and opened a consulting-engineering office in New York with a fair degree of success, until it became necessary to again take charge of the Uehling Instrument Company of which I had been president from the beginning. After fifteen years of ups and downs in the instrument-manufacturing business, during which time my oldest son, Frederick F., was my able and efficient assistant, I turned the management over to him and retired, in the 70th year of my life.

Shortly after retiring I moved back to Wisconsin where I was born and raised in a pioneer family of eleven children, five older and five younger than I, which makes it self-evident that I have a large number of nephews and nieces. I took an interest in their occupations and well-being and made it my hobby to keep in touch with them by correspondence and visits, and with one another by means of a picnic of the Uehling family every year. I also wrote quite a number of essays, had them multi-typed, and mailed to them for their amusement and edification. All of this has kept me fully and quite pleasantly occupied.

From a strictly material and technical standpoint, it may seem that I wasted a lot of engineering talent, which may be true. Nonetheless, I feel that I did a job of human engineering of which I am even more proud than of what I accomplished during my active years in the profession of mechanical engineering.

ASME NEWS

Excellent Program Draws Large Attendance at ASME 1949 Spring Meeting

Lyman J. Briggs Honored

AT THE WELCOMING LUNCHEON, MONDAY, MAY 2

(*Left to right*: James M. Todd, president ASME, and Harry R. Westcott, president, Westcott and Mapes, Inc., New Haven, Conn., who delivered the main address.)

THE 1949 Spring Meeting of The American Society of Mechanical Engineers held at the Mohican Hotel, New London, Conn., May 2–4, was a rewarding experience for more than 500 members and guests who participated in its program of technical sessions, social events, and inspection trips. The program was sufficiently broad and the attendance sufficiently large for everyone present to take away from New London some new knowledge, some pleasant experience, and a wider circle of friends in the ASME. The Society is indebted to the five Connecticut Sections of the Society, Fairfield County, Hartford, New Haven, New London, and Waterbury, whose gracious hospitality and organizational skill provided for East Coast members what was virtually the counterpart of the Semi-Annual Meeting to be held in several weeks in San Francisco, Calif.

Technical Fare

The well-balanced program provided rich fare in such fields as power, management, education, aviation, machine design, heat transfer, and many others. Under the Society's publications plan practically all of the papers presented at the meeting will come to the attention of members in one way or another. Two of the papers have already appeared in full in the May issue of MECHANICAL ENGINEERING, and several more are now being set in type. Digests of 11 papers received well in advance of the meeting appear in the "Technical Digest" section of this issue. Others will appear in forthcoming issues. Copies of all digest papers are available at headquarters and may be purchased at members' price of 25 cents each, or nonmembers' price of 50 cents. Papers for which no preprints were prepared will be abstracted in "Briefing the Record" section, if authors have submitted manuscripts to headquarters.

Scenic New England

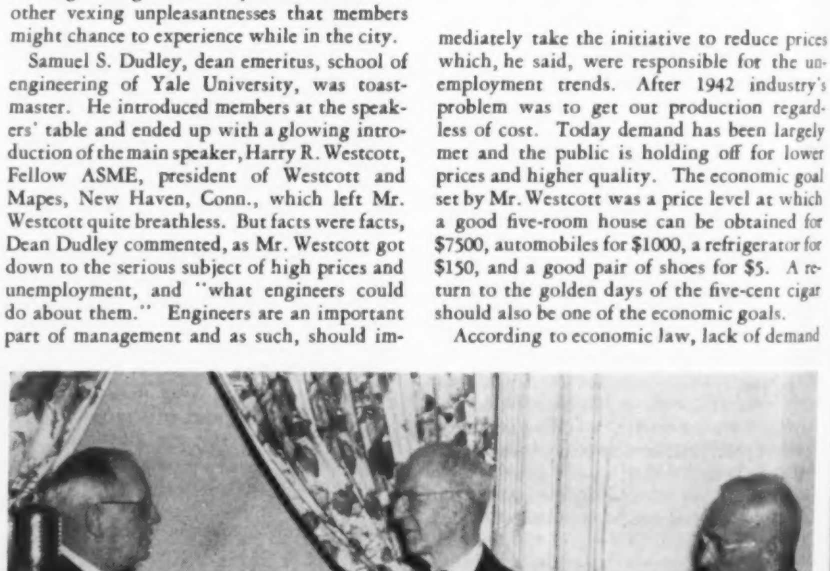
The ASME instinct for good fellowship was very much in evidence as more than 160 members and guests began arriving late Sunday afternoon. After registering and picking up handfuls of literature about New London and the program of the meeting, they gathered in the lobby of Hotel Mohican to greet old friends as they arrived. Later Sunday evening in the Florentine Room 200 superb color photographs were shown of the scenic spots of Connecticut and other New England states. The photographs were the work of A. C. Crownfield, Jr., Mem. ASME, The Allen Manufacturing Company, Hartford, Conn., whose running commentary carried the audience through historic cities and into ancient New England homes. Glenn B. Warren, commenting on the artistic quality of the shots, said that contrary to the popular impression of engineers as devoid of the artistic sense, it was his impression that when he has enjoyed illustrated travelogues, they were usually the work of an engineer who has taken up photography as a hobby.

Overhauling the Price Structure

New London, officially represented at the meeting by Francis F. McGuire, city clerk, literally opened its door to members and guests of the Society at the welcoming luncheon by offering to forget about any traffic tickets and other vexing unpleasantnesses that members might chance to experience while in the city.

Samuel S. Dudley, dean emeritus, school of engineering of Yale University, was toastmaster. He introduced members at the speakers' table and ended up with a glowing introduction of the main speaker, Harry R. Westcott, Fellow ASME, president of Westcott and Mapes, New Haven, Conn., which left Mr. Westcott quite breathless. But facts were facts, Dean Dudley commented, as Mr. Westcott got down to the serious subject of high prices and unemployment, and "what engineers could do about them." Engineers are an important part of management and as such, should immediately take the initiative to reduce prices which, he said, were responsible for the unemployment trends. After 1942 industry's problem was to get out production regardless of cost. Today demand has been largely met and the public is holding off for lower prices and higher quality. The economic goal set by Mr. Westcott was a price level at which a good five-room house can be obtained for \$7500, automobiles for \$1000, a refrigerator for \$150, and a good pair of shoes for \$5. A return to the golden days of the five-cent cigar should also be one of the economic goals.

According to economic law, lack of demand



PRESIDENT TODD OFFERING DR. LYMAN J. BRIGGS (*center*) THE GOOD WISHES OF THE SOCIETY AFTER HE HAD RECEIVED THE CERTIFICATE OF HONORARY MEMBERSHIP. IRVING E. MOULTROP, HON. MEM. ASME, IS STANDING TO THE RIGHT

will stimulate competition which will in turn tend to lower prices. If engineers allow business to wait for the working of such laws, the recession will develop into a depression, the lowering of prices will be sporadic, and by the time some managements decide to cut prices their decisions will be made in a distress atmosphere of unemployment and economic suffering. Voluntary price reductions now will increase demand, stimulate consumer buying, and reverse the unemployment trend. Initiative is the responsibility of engineers since they are the creators and maintainers of the country's productive machinery. Mr. Westcott urged engineers to overhaul this machinery on a new reduced-price basis.

Two methods are open to engineers: First, they can take joint action through their professional organizations in co-operation with chambers of commerce, trade and labor organizations, to spread the lower-price philosophy. Second, they can individually set the pace by redesigning their products, introducing cost-saving new materials and methods, and finally oppose the confiscation of earnings by excessive taxation which is drying up the source of investment capital.

JOHN W. NICKERSON, DIRECTOR OF INDUSTRIAL RELATIONS, BIGELOW, KENT, WILLARD AND COMPANY, BOSTON, MASS., PRESIDING AT THE SYMPOSIUM ON SMALL-PLANT MANAGEMENT

(*Left to right:* W. C. Beekley, president, The Whitlock Manufacturing Company, Hartford, Conn.; Oliver P. Swope, Massachusetts Institute of Technology, Cambridge, Mass., and Mr. Nickerson.)

Small-Business Management

Four phases of the problem of how small business could keep its production above the break-even point in an economy of high material and labor costs were discussed by a panel of four speakers at the Management session on Monday evening, May 2. The points of view were those of two presidents of small Connecticut manufacturing organizations and two New England educators. American business, 90 per cent of which is composed of units employing 100 persons or less, is a potent force in the struggle against the fallacious doctrine of socialized government, they said.

W. C. Beekley, president of the Whitlock Manufacturing Company, Hartford, Conn., stated that communication within small industrial plants which develops the sincere interest of the employee in his company and helps him to understand his function in it is the key to reducing costs. Three factors are important if management's communication is to be effective. Against the false doctrine of governmental paternalism, management must first choose favorable grounds upon which to make its stand, and then develop the fundamental principles of its case for free enterprise, and finally express these principles simply and continuously to its employees. Keeping its employees informed on business facts will generate in time a feeling of common achievement within a producing unit based on the principles of the dignity of the individual, loyalty to fellows on the team, the human desire for recognition, and the will to own private property.

Oliver P. Swope, Jr., instructor in business and engineering administration at the Massachusetts Institute of Technology, stated that while the economy was shrinking and small business stands at an economic disadvantage to big corporations, it, nevertheless, has one important advantage, that of the nearness of management to the workers. By tapping the ideas of workers on the machines, who are the men in the company who know most about the details of the jobs, small business can achieve the cost reduction to keep it well above the break-even point in production. Mr. Swope mentioned the Lincoln Electric Company where management by workers has made it possible for the company to pay the highest wages in the country, perhaps in the world, while at the same time underbidding its competitors. He cited another bicycle company which, by utilizing ideas of the lower echelons, increased production from 960 units per day to more than 1500.

The matter of developing management personnel by small industry was discussed by Myles L. Mace of the graduate school of business administration, Harvard University. Reporting on the preliminary results of a research project in this field, Mr. Mace told the session that there is no quick cure for a business in trouble. Management training is a slow and painstaking job in which success seems to lie in the principle that potential managers learn best by doing tasks of progressive responsibility. The study also points to a man's immediate superior as his best teacher. Training managers by the "sink or swim" method was costly and wasteful. Subordinates must be encouraged to assume responsibility for recommending decisions to immediate superiors.

Carl A. Gray, president of the Granby Manufacturing Company, Plainville, Conn., touched on the social significance of small business which in numbers of employees involved, is actually big business. Small business must face the responsibility of absorbing young workers, he said. Under present conditions, with high costs and small profit margins, small business is not financially able to train its own men. While it gets some relief by stealing talent trained by large corporations, the supply is not sufficient to meet its needs. Something is wrong in the country when able young men with no previous training find no opportunity at the doors of small business. It is not surprising that young people have been lulled into accepting handouts of government. To create the climate needed for free enterprise, businessmen must begin in the schools to direct education into the channel of training for production so that young people can develop their talents for creation of wealth.

Engineer's Professional Philosophy

The mechanical engineer's professional philosophy, which has brought about the development of the physical world, must now be widened to bring about the development of men, F. Alexander Magoun, associate professor of human relations at the Massachusetts Institute of Technology, told the General Luncheon on Tuesday, May 3. Applied in other fields, the engineer's philosophy could bring about co-operation and understanding in industry, religion, politics, and the home, he asserted.

Professor Magoun's address, prepared in collaboration with R. Carter Nyman, personnel director of Yale University, described the philosophy as basically one of truth, reason, and integrity, beginning with an attempt to recognize and define the problem to be solved and continuing with a sincere search for the applicable laws of the government of nature. He said:

"The engineer's philosophy is relatively simple yet so incredibly effective he has acquired great confidence that any results he predicts will be achieved. The engineer endeavors to apply his principles in the most effective way and to discover what he has learned in the application thereof."

"If we are not to destroy each other, we must apply the philosophy and morality of science to the engineering of human relations."

Professor Magoun said the engineer has replaced our original insecurity and terror of the forces of nature with understanding, respect, and co-operation with the laws of nature, gained only by following a philosophy of truth, reason, and integrity.

Since man is as dependent upon his fellow men as he is upon nature, human problems should be approached with as much profes-

sional competence as the engineer employs in pursuing technical problems, Magoun asserted.

"Instead of trying to understand each other, we have endeavored to coerce when we felt strong and to entice when we felt weak," the professor said. "The result has been a false philosophy of human relations, intolerable relationships of fear, false values, superficial compromises, and dishonesty which have never led to constructive solutions."

Electric-Power Generation

The past and future of electric-power generation was the subject discussed by Irving E. Moultrop, Hon. Mem. ASME, at the joint Fuels and Power Divisions luncheon on Tuesday, May 3. One of the pioneers in the electric-power industry, Mr. Moultrop recalled the severe physical hardships of boiler firing 50 years ago. "Fire rooms were hot, dark, and dirty," he said, "and firemen were required to shovel 8 to 10 tons of coal per watch and to work 12 hours per day, seven days a week."

Since 1886 the price of coal has changed from $2.30 a ton to around $10, making it economical in many cases to burn oil on a competitive basis. Use of oil for generating electric kilowatts, he said, was an "economic blunder" because oil is the essential fuel for the internal-combustion engine and the source for lubricants and other valuable chemicals. The alarming increase in the consumption of fossil fuels makes the question of how long our domestic supplies will last a vital one to the economy of the nation. Quoting an expert in the fuels field, Mr. Moultrop reported that increasing demand and the conversion losses of transforming fuels from solids to liquids and gases would exhaust the supplies within 92 to 93 years.

Future sources of electric energy, Mr. Moultrop said, lie in solar and atomic energy. For marine power, electric utilities, and military aircraft, atomic energy holds much promise. Finding valid ground for optimism in the fuels picture, Mr. Moultrop concluded, "this country has never yet failed to find the answer to economic or industrial needs, and we are not going to fail now."

Dr. Briggs Honored

The high point of the meeting was reached at the banquet on Wednesday, May 3, when, after an excellent dinner, Frank B. Gunby, vice-president, ASME Region I, felicitated the five Connecticut host Sections on the triumphant success of their collaboration. Colonel Gunby introduced honored guests at the speakers' table and singled out for special attention two student members who were representing student members of the Connecticut student branches. They were Arthur Twitchell, chairman of the University of Connecticut Student Branch, a member of whose organization won first prize at the Region I student conference, and Kenneth Cunningham, secretary of the Yale University Student Branch. Turning to Irving Moultrop, Hon. Mem. ASME, a pioneer in the development of the electric-power industry, Colonel Gunby told the guests that he was taking this occasion to christen Mr. Moultrop, "the much beloved and respected dean of engineers of Boston." Others at the speakers' table were: A. R. Mumford and Paul B. Eaton, vice-presidents, Regions II and III, respectively; Lyman J. Briggs, director emeritus, U. S. Bureau of Standards, present to receive the certificate of honorary membership; James M. Todd, president ASME; Rear Admiral James Fife, main speaker; Frederick S. Blackall, Jr., and William M. Sheehan, directors at large, ASME; L. A. Lachmann, general chairman of the 1949 Spring Meeting; and C. E. Davies, secretary ASME.

Following his introduction, Professor Lachmann asked members of his committees to stand and receive the applause of the audience.

Colonel Gunby next called on Mr. Davies to officiate at the presentation of the certificate of honorary membership to Dr. Briggs. Mr. Davies explained that honorary membership in The American Society of Mechanical Engineers was the highest honor the Society can bestow on persons of acknowledged professional eminence. To the roster of 125 engineers and scientists on whom honorary membership has been conferred in the 68 years of the life of the Society, the name of Lyman J. Briggs was now being added. "Dr. Briggs is a renowned scientist," Mr. Davies continued, "and, until his retirement, distinguished administrator of the National Bureau of Standards. Dr. Briggs has spent his active life as a scientist and administrator of research. As chief of the Division of Mechanics and as director for twelve years, his work is well known to engineers throughout the world. The growth of the Bureau in scientific work and its success in the solution of difficult problems in engineering, physics, chemistry, and mathematics attest to his leadership and inspiration. He was chairman of the original uranium committee to study the use of nuclear energy in war. In addition to bearing the tremendous additional war load that fell on his shoulders as head of the Bureau, he continued his connection with the research that resulted in the success of the atomic bomb. He has made many inventions of far-reaching value and he has contributed freely to scientific publications throughout the world."

Mr. Davies called on Mr. Moultrop who presented Dr. Briggs to President Todd, who handed to Dr. Briggs the certificate of honorary membership with the good wishes of the Society.

Dr. Briggs spoke briefly, acknowledging the honor, and recounting his pleasant association with the ASME during the long negotiations and development of the unified screw-thread standards recently adopted by Great Britain, Canada, and the United States.

The Road to Peace

Speaking on the subject, "The Road to Peace," Rear Admiral James Fife, Commander of the Submarine Force of the U. S. Atlantic Fleet, U. S. Submarine Base, Groton, Conn., urged his fellow countrymen to have unbounded faith in the future of America but not to trust their security to hope alone.

Admiral Fife briefly sketched his career through two world wars and service in many foreign countries, during which he had the opportunity to observe the destructive effects of foreign ideologies. His experience had convinced him, he said, that American security lay in her "industrial capacity," and that the communist ideology, out to destroy our system of free enterprise, would endeavor to defeat us from within "if we are stupid enough to let them get away with it."

World War III can be prevented, he said, only if America preserves her internal and external strength by maintaining its present system.

"Given time," he continued, "Communism will fall of its own weight because it is supported by a false foundation." The strength of American democracy lies in her armed forces, the economic stability of her economy, and the reliability and integrity of her people. To maintain this strength each citizen individually must analyze and understand the reasons for his belief in American democracy.

President Todd, in acknowledging Admiral Fife's admonitions, stated that the ASME, composed of professional men, blessed with a

THE FUELS-POWER DIVISION LUNCHEON AT THE CROCKER HOUSE BEFORE WHICH IRVING E. MOULTROP, THE "BELOVED AND RESPECTED DEAN OF ENGINEERS OF BOSTON" REVIEWED CURRENT TRENDS IN ELECTRIC-POWER GENERATION

(*Left to right*: E. B. Powell, Stone and Webster Engineering Corporation; Mr. Moultrop; Glenn B. Warren, General Electric Company, Schenectady, N. Y.; and William F. Ryan, Stone and Webster Engineering Corporation.)

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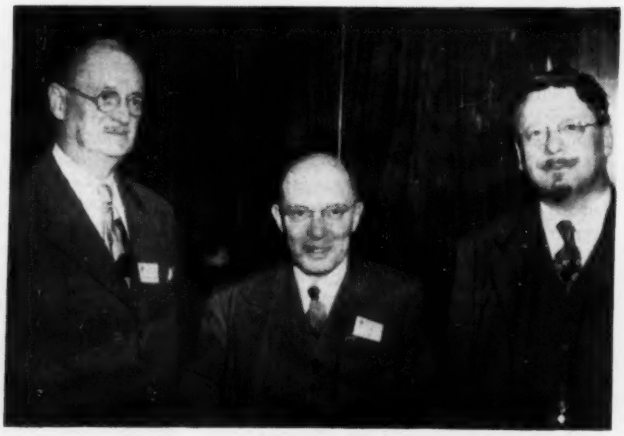

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Random Shots at the 1949 Spring Meeting

[(1) *Left to right:* Donald B. Prentice, S. W. Dudley, and Ernest Hartford. (2) Mrs. J. P. Heumann, Mr. Heumann, Mrs. L. A. Lachman, John F. Banthin, and Mrs. Banthin. (3) Andrew McKee, Mrs. Harry MacDonald, Mr. MacDonald, Mrs. John S. Leonard, Mr. Leonard, Mrs. Frank T. Horan, Mr. Horan, and Mrs. Walter E. Beaney. (4) Looking over the preprints on sale at the ASME publication-sales desk. (5) John Haydock, B. P. Graves, and Colin Carmichael; and (6) H. E. Harris, R. C. Nyman, and F. Alexander Magoun.]

AT THE SYMPOSIUM ON THE FIVE-YEAR CURRICULUM

proper education and endowed with the mantle of leadership, was accepting responsibility on questions of vital public interest. The ASME Engineers Civic Responsibility Committee was preaching the gospel of individual participation in city, state, and national affairs.

Citing Greece as an example of what happens to a democracy burdened by the sins of bureaucracy, President Todd said that her six million people enjoy an electric-power capacity of 200,000 kw in contrast with 12 times that amount which is available to the equivalent population of New York City. American engineers are helping to build the road to peace by aiding impoverished nations who wish to help themselves, he asserted.

Through the Engineers Joint Council, in which ASME is working with other engineering societies, "the engineering profession is doing its best to support the work of Economic Co-Operation Administration by aiding in selection of personnel, in interchange of know-how with visiting delegations from foreign countries, and by visits to engineers in other countries. ASME is giving strong support to sponsoring participation in the first Pan-American Engineering Congress at Rio de Janeiro in July. To this will come fifty engineers from the United States. EJC represented U. S. engineers at the World Engineering Congress at Cairo in March. Both EJC and ASME will be represented at the conference of engineering societies of Western Europe and the United States at London in September. This is active work. Engineers are doing the pick-and-shovel work on the road to peace. Whereas Mr. Truman in his inaugural address, called for bold steps for making our industrial progress available to undeveloped areas, the engineers have for generations been doing just this."

Engineering Education

While good engineering education points to a five-year curriculum, many sound economic arguments stand in opposition to such a plan, according to C. V. Newsom, assistant commissioner of higher education, University of the State of New York, Albany, N. Y., who was lead-off speaker at a symposium which analyzed the five-year engineering curriculum from several viewpoints. Mr. Newsom emphasized four important trends in engineering education: (1) Emphasis in high schools on general education rather than on preparation for a specific professional career; (2) development of technical-institute programs which aim at positions between the trades and accepted engineering practice; (3) growing conception of the engineer as a professional man of broad educational background as well as of special understanding; and (4) the rapid increase in the cost of education which was keeping brilliant young men of the low-income families out of the colleges.

The five-year curriculum was characterized by K. B. McEachron, Jr., manager, technical-education division, General Electric Company, as an experiment, the results of which must not be prejudged. The curriculum ought not to be extended indiscriminately among the institutions until its value has been proved experimentally. A conclusive answer should not be expected for a decade. He pointed out that the industrial accomplishments of America show that an effective job of engineering education has been done. This effectiveness of the four-year curriculum was sufficient reason alone to move cautiously until the results of the experiment are known, Mr. McEachron concluded.

Needs of the Student

As the third speaker of the panel, S. W. Dudley, dean emeritus, school of engineering, Yale University, emphasized that it was the student who was the crux of the real problem of education. "He needs opportunity, examples, and stimulus to develop for himself insight and understanding. This is not accomplished by precept from without, but by association and participation with others, differing widely from himself in specific fields of interest but engaged alike in the pursuit of knowledge and in the acquisition of the art of its constructive utilization," Dean Dudley said.

The problem of leading students through a genuine educational experience was a difficult one, he continued. Yale University has used the seminar method since the early 1920's to help students toward self-development. The method is useful because it gives the student familiarity with ways and means of acquiring for himself understanding and the ability to analyze outside his own field of science and engineering, to cultivate a habit of doing his own thinking, and of scholarly expression.

Speaking as a representative of industry, R. H. McCarthy, superintendent of manufacturing engineering, Western Electric Company, Kearny, N. J., reported the results of a survey made among his company's supervisors on the value of the five-year curriculum. The consensus was that most of the graduate engineers at Western Electric Company were employed in operations and manufacturing planning, and that these men get sufficient engineering in the four-year curriculum to make a good start in industry. The specialists in design and development, who make up a smaller group, might benefit from a five-year curriculum if the extra time were used judiciously to give perspective to life and a truer sense of human values.

Mr. McCarthy cautioned that while the fifth year is generally assumed to be to give extra time for the humanities, some institutions are thinking of it as extra time for more engineering.

The small employer's view of the five-year curriculum was reported by B. P. Graves, director of design, Brown and Sharpe Manufacturing Company, Providence, R. I. Basing his comments on experience with graduates in the machine-design industry, Mr. Graves said that in his opinion a graduate engineer, taught correctly and drilled thoroughly in the fundamentals of engineering, able to express himself in writing, and subjected to a reasonable amount of humanistic training in a four-year course, can fit into machine-design work as well as an engineer who has come through the five-year program. He suggested that more effort be directed "to teaching logical think-

O. F. WILLHELM, VICE-PRESIDENT, DURHAM-ENDERS RAZOR CORPORATION, MYSTIC, CONN., INTRODUCING FREDERICK S. BLACKALL, JR. (*left*), WHO ADDRESSED THE WEDNESDAY LUNCHEON

ing, analytical methods of solution, and critical selection of results." The four-year curriculum could be streamlined, he said, to include much that is being considered for the 5-year course.

Economic Recovery in Europe

The final luncheon of the Spring Meeting was held on Wednesday when more than a hundred members heard Frederick S. Blackall, Jr., director at large ASME, and president of the Taft-Peirce Manufacturing Company, Woonsocket, R. I., state that the United States, having linked itself with socialist Europe, was in danger of becoming infected.

The socialist planned economy "first, by definition limiting human independence, soon tends, as it has in Russia (and elsewhere) to generate dictatorship and the suppression of human rights," he asserted. In aiding Western democracies it is important that the United States should condition her assistance to insure that she is not financing "further excursions into nationalism or other systems repugnant to our principles of human liberty and freedom of enterprise."

Such a stipulation would not be "forcing our views on others," Mr. Blackall contended, but would merely be setting reasonable limits on how our money should be spent, or rather how it should not be spent—a thing this country has a right to do.

The crux of Western Europe's economic recovery lies in a dependable supply of dollar exchange, which means that we must buy what Europe has to sell. American business must sacrifice some of its "cherished economic principles," especially "the principle of protection through a high-tariff wall," if Europe was ever to provide her own dollar exchange. The dilemma facing the United States was that she must support European democracies by providing loans or by opening her markets to foreign competition.

Many members took advantage of the interesting side trips planned by the host sections. On Monday more than 30 members and guests made the bus trip to East Hartford to inspect the plant of the United Aircraft Corporation, and observe the production and testing of the Wasp air-cooled radial aircraft engines. The plant has a floor area of 50 acres and is served by the nearby Rentschler Airport with its three-mile-long runways.

On Tuesday morning another group visited the Mystic Marine Museum where they saw relics of the whaling industry. The museum houses many old logs giving accounts of whaling voyages, and models of many whaling ships. Tied to the pier behind the museum are the old whaler, *Charles W. Morgan*, and the windjammer, *Joseph Conrad*, fully restored to their original condition.

Five buses were required to take the party to the U. S. Submarine Base in Groton, Conn. Here one of the largest and most modern of the country's submarines was inspected. Several small German and Japanese midget submarines were also on display. On Wednesday morning 50 members left for the Montville Station of the Connecticut Light and Power Company at Uncasville, Conn., after listening to a description of the station by Montville engineers. In a recent expansion of the station, two 300,000-lb per hr coal-fired boilers were installed along with two 35,000-kw turbogenerators. This modern equipment made possible an economy of 11,400 Btu per kwhr.

Committees

The following Committees of the Connecticut Section were responsible for the success of the meeting: *General*, L. A. Lachman, general chairman, Robert Wosak, J. P. Heumann, A. C. Crownfield, Jr., R. J. Andrews, Jr.; *Publicity*, Willis F. Thompson, chairman, Gustave Welter, Michael J. Radecki; *Technical Events*, Charles H. Coogan, Jr., chairman, David A. Fisher, Ronald S. Brand, John Parker; *Hotel*, John S. Leonard, chairman, Frank T. Horan, J. Vincent Harrington; *Entertainment and Banquet*, Thomas M. Rianhard, Jr., chairman, Charles M. Warner, Walter E. Allan, Richard Simpson, H. R. Shailer, Jr.; *Information and Registration*, Wm. E. Hogan, chairman, Warren Schmidt, W. H. Lesser, Bruce McNaughton, C. W. Morse, Geo. Brown, James L. Corcoran, James F. Young, John H. Palmer, Ernest A. Kroder; *Plant Trips*, Richard L. Weil, chairman, Gustave L. Manke, Carl A. Geissler, E. I. Kelsey, E. R. Lewis, Jr., Nicholas A. Welch; *Printing and Signs*, Erich R. Stephan, chairman, Peter W. Rogan; *Reception*, Edward H. Walton, chairman, Richard L. Anthony, Lawrence R. Babcock, J. S. C. Barry, Walter E. Beaney, Arthur Brewer, Charles Ecklund, J. P. Heumann, George R. Holmes, Lester C. Lichty, John O. Mullen, Roy L. Parsell, Charles W. Phelps, Michael J. Radecki, Gustave Welter, Russell G. Warner, James F. Young; *Finance*, A. C. Crownfield, Jr., chairman; *Women*, Wm. E. Hogan, chairman, Mrs. L. A. Lachman, vice-chairman, Mrs. John S. C. Barry, Mrs. Ralph D. Briggs, Mrs. Charles H. Coogan, Jr., Mrs. John S. Leonard, Mrs. Walter E. Beaney, Mrs. J. V. Harrington, Mrs. Francis T. Horan, Mrs. Howard E. Kuehn, Mrs. Erich R. Stephan, Mrs. Oscar F. Wilhelm, Mrs. Cecil N. Hoagland, Mrs. John P. Heumann, Mrs. Lester C. Smith, Mrs. Richard L. Weil, Mrs. Albert S. Redway, Mrs. Edward H. Walton, Mrs. Richard W. Simpson.

WIVES OF MEMBERS WAITING FOR CARS TO TAKE THEM TO THE HISTORIC HEMPSTEAD HOUSE AND THE NATHAN HALE SCHOOLHOUSE

ASME Calendar
of Coming Events

June 13–15
ASME Applied Mechanics Division Conference, H. A. Rackham School of Graduate Studies, University of Michigan, Ann Arbor, Mich.

June 27–30
ASME Semi-Annual Meeting, University of California, Extension Building, San Francisco, Calif.

Sept. 12–16
ASME Industrial Instruments and Regulators Division Conference and Exhibit, Municipal Auditorium, St. Louis, Mo.
(*Final date for submitting papers was May 1, 1949*)

Sept. 27
ASME Wood Industries Division Conference, Jamestown, N. Y.
(*Final date for submitting papers was May 1, 1949*)

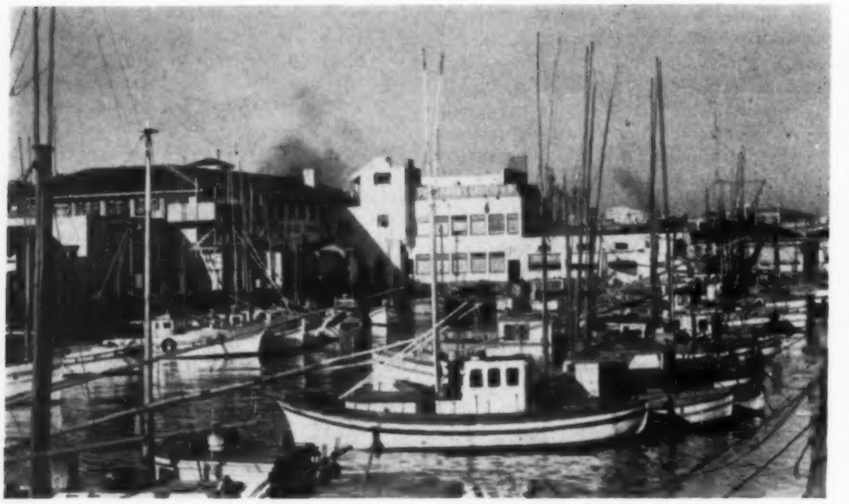
Sept. 28–30
ASME Fall Meeting, Erie, Pa.
(*Final date for submitting papers was May 1, 1949*)

Oct. 2–5
ASME Petroleum Division Conference, Oklahoma Biltmore Hotel, Oklahoma City, Okla.
(*Final date for submitting papers was June 1, 1949*)

Oct. 26–27
ASME Fuels Division Conference, French Lick Springs Hotel, French Lick Springs, Ind.
(*Final date for submitting papers was June 1, 1949*)

Nov. 27–Dec. 2
ASME Annual Meeting, Hotel Statler, New York, N. Y.
(*Finaly date for submitting papers—Aug. 1, 1949*)

(*For Meetings of Other Societies see page 529*)



FISHERMAN'S WHARF, SAN FRANCISCO, CALIF., HOST CITY OF THE 1949 SEMI-ANNUAL MEETING OF THE ASME

San Francisco Section to Play Hosts to Society at 1949 Semi-Annual Meeting

THE San Francisco Section, hosts for the 1949 Semi-Annual Meeting of The American Society of Mechanical Engineers to be held in San Francisco, Calif., June 27–July 1, 1949, has planned a program replete with the extras of entertainment and hospitality which add so much to meetings of the Society. ASME headquarters during the Meeting will be the Fairmont Hotel, but all technical sessions will be held in the University of California Extension Division Building, 540 Powell Street. The tentative program appears on pages 444 to 447 of the May issue. In addition to the excellent technical program with its 27 sessions and more than 60 papers, the special trips to research centers, power plants, and to some of the natural wonders of California, add up to the ideal vacation for an engineer and his family.

"Mechanical-Engineering Frontiersmen" will be the subject of President Todd's address at the banquet on Wednesday, July 26.

As evidence of the appeal of the Meeting, more than 50 members from the East and Middle West have signed up for the special ASME conducted tour which will take the party through many of the famous National Parks of the country in a private Pullman car to and from the Semi-Annual Meeting.

Special provisions have been made for the entertainment of wives of members. The women's program features luncheons at many of San Francisco's famous restaurants, visits to scenic spots in the San Francisco Bay vicinity, and to cultural monuments of this West Coast metropolis. The morning hours of each day have been set aside for shopping. Of special interest will be the shop of Podesta Baldocchi, famous florist, whose window displays are known all over the world. Another shop which should not be missed is Gump's, where there is a collection of jade, European treasures, and the work of California artists.

Members are urged to make hotel reservations as early as possible. For this purpose an ASME Housing Committee has been organized. Rooms have been set aside in eight of San Francisco's leading hotels. A list of these hotels and rates for various accommodations are given in the table on this page. For convenience in making requests for reservations, use of the form on the next page is suggested.

Official Notice

ASME Business Meeting

THE Semi-Annual Business Meeting of the members of The American Society of Mechanical Engineers will be held on Monday, 11:15 a.m., June 27, 1949, in the University of California Extension Building, San Francisco, Calif., as part of the Semi-Annual Meeting of the Society.

Special Trips

A brief of some of the special trips follows:

On Monday afternoon, June 27, Capt. B. E. Manseau, commander of the San Francisco Naval Shipyard, will act as host on the inspection tour of the 600-acre base, rated the Pacific's No. 1 Navy repair facility.

The party will travel by motor launch from a San Francisco pier to Hunter's Point, getting a mariner's-eye view of the bay. While at the base, Navy buses will convey the group to the various points of interest. Scheduled is a visit to the submarine *Dentuda*, veteran of the Bikini atom-bomb maneuvers, now a floating Naval Reserve Armory. The visitors will be shown the drydocks, some Navy ships in "mothballs," the world's mightiest crane, and the ordnance-electronic shop.

On conclusion of the tour the group will again board the launch for the return sightseeing trip to the San Francisco water front.

Radiation Laboratory

For those who would view the cradle of the atomic age, a visit on Tuesday afternoon is planned at the University of California Radiation Laboratory, where the world's most powerful atom smasher will be open for a conducted tour.

Buses will take the party from San Francisco to the campus where W. M. Brobeck, assistant director of the Radiation Laboratory, will be host. Marvin Martin, mechanical engineer at the laboratory, will brief the group on the giant 4000-ton cyclotron, its operation, and its role in the nuclear unknown.

Items of interest to be shown at the laboratory will include the cyclotron, and its two new aggregates, the synchrotron, and the linear accelerator.

The synchrotron, recently completed, is another tool of nuclear research. It is used to accelerate only electrons which are boosted up to an energy of 300 million electron volts. The linear accelerator, new research device, is designed to shoot atomic projectiles riflelike rather than in the merry-go-round method of other atom smashers. It is a forerunner of a future device that will hurl protons of a billion or more electron volts.

United Air Lines Maintenance Base

United Air Lines will receive ASME visitors on Tuesday, June 28. Starting with a luncheon in the United cafeteria, the members will then see a new and very remarkable "push-button" aircraft maintenance base.

The permanent overhaul dock, a series of specially designed steel catwalks and ramps, used by United for major overhauls on DC-4 and DC-6 type airplanes, will be of interest to all engineers to see.

Also to be shown is the engine-overhaul shop, a conveyerized operation capable of turning out eight rebuilt engines a day. The trip will continue with a tour of the plant to include the engine-test, propeller-overhaul, instruments, and radio electric overhaul departments. As many as eight four-engine mainliners can be overhauled simultaneously.

ASME HOTELS AND RATES AT SEMI-ANNUAL MEETING

Hotels	*Single*	*Double*	*Twin*	*Parlor Suite*
Bellevue	—	$ 7	$ 7–$ 8	$15
Fairmont	—	$ 8–$13	$ 8–$13	$22–$32
Fielding	—	$ 5–$6	$ 6–$ 7	— —
Manx	$ 4	$ 5		
Mark Hopkins	$8–$10	$10–$14	$12–$14	$20–$35
Palace	—	$ 9–$12	$10–$13	$22–$39
Sir Francis Drake	—	$ 8–$10	$ 9–$11	— —
Stewart	—	$ 5–$6	$ 6–$8	— —

Transportation will be provided from downtown San Francisco to the airport at South San Francisco.

Station "P"

An inspection trip through Station "P," the newest and largest steam-operated electric-generating plant on the Pacific Coast, has been arranged for Thursday afternoon, June 30. D. D. Smalley, vice-president in charge of operations for the Pacific Gas and Electric Company, will be the host for the occasion.

Station "P" is located on San Francisco Bay just north of Hunter's Point Dry Dock and has a total capacity of 360,000 hp. Primarily it is a base-load plant and at times operates at low loads, but is capable of developing a full load in a matter of 20 or 30 seconds. It was placed in service Feb. 8, 1949.

In addition to viewing the most modern of turbogenerators, high-pressure boilers, and other power-plant equipment, the fundamental plan for the plant will be of great interest from the standpoint of centralized control. The layout of the equipment is such that the boilers, turbines, feedwater pumps, and electrical equipment are arranged on one floor level and surrounding the control room; thus the control operator is at the key point and able to observe all the major equipment and most of the employees from his operating station. As a result of this arrangement, and the extensive use of air-operated automatic controls, it requires less than ten employees to operate this huge power station.

ASME National Nominations

THE 1949 Nominating Committee invites members to appear at its open meeting June 27–28, 1949, at the University of California Extension Division Building, 540 Powell Street, San Francisco, Calif., where the Semi-Annual Meeting will be held. Members may present their views concerning candidates for the office of President, Regional Vice-President, and Director at Large any time between the hours of 9:30 a.m. to 12 noon.

Transportation will be provided for the members making this trip.

NACA Ames Aeronautical Laboratory

An inspection trip of extreme interest has been arranged for Thursday afternoon, June 30, to the NACA Ames Aeronautical Laboratory at Moffett Field. S. J. De France, director of the laboratory, will act as host for the group.

The laboratory is chiefly devoted to high-speed aerodynamic research and provides knowledge unavailable from other sources. The largest wind tunnel in existence is located at this laboratory as well as some of the highest-speed tunnels. Because of the classified nature of the work being conducted, it is impossible to state exactly which tunnel and equipment will be included in the inspection.

The Ames Laboratory also conducts a flight-research program and the installation involved will be shown to the visitors.

Members visiting the Ames Laboratory will be transported from San Francisco in chartered buses, and will gather for luncheon at one of the well-known San Francisco peninsula restaurants prior to the inspection trip.

Record Attendance at Time Study and Methods Conference

MORE than 1500 management engineers and executives attended the Fourth Time Study and Methods Conference sponsored by the Society for Advancement of Management and the Management Division of The American Society of Mechanical Engineers, held at the Hotel Statler, New York, N. Y., April 21 and 22, 1949.

Speaking on the subject, "A Practical Approach to Fatigue Allowances in Time Study," Edmund A. Cyrol, Mem. ASME senior staff engineer, A. T. Kearney and Company, Chicago, Ill., pointed out that "fatigue" is unmeasurable, almost indefinable, and full of paradoxes. In spite of this, labor unions demand a simple treatment of fatigue allowances. Using a typist's rest period to illus-

Hotel Room Reservation Request Form

MAIL TO: ASME Housing Committee, Room 200, 61 Grove St., San Francisco 2, Calif.

Please make Room Reservation noted: (Use hotels listed or other hotels)

1st Choice	Hotel....................................	Single Room	@$..........
2nd Choice	Hotel....................................	Double Room	@$..........
3rd Choice	Hotel....................................	Twin-Bed Room	@$..........
OTHER-TYPE ROOM	....		@$..........

Arriving Day.................... Date.................... at..........a.m.........p.m.

Leaving Day.................... Date.................... at..........a.m.........p.m.

Room will be occupied by

Name .... *Address* ....

....

....

Check for $..........is enclosed to bind this reservation.

Signed..

Address..

City..

(Deposits of $5 per person or $10 per room required with this form)

trate his thesis, Mr. Cyrol reported that on the basis of calories expended, it will be found that a typist on her rest period expends 50 to 100 per cent more energy walking about and talking to her friends than she does when she is working.

At the same session on Friday morning Harold Von Thaden, vice-president and general manager of the Robins Engineers Division of Hewitt-Robins Inc., predicted that the belt conveyer and related heavy conveying techniques would undergo their greatest technical development in history in the next 10 years. One incentive to this development would be, he said, the need to make usable products out of low-grade iron ores in the face of depletion of high-grade ore deposits.

"If we are to protect our domestic sources of iron ore (by processing the lower-grade ores), provide the fuel for the rapidly rising electrical-power requirements, and, on top of this, produce synthetic fuels from coal, we will have to prepare to recover 400,000,000 more tons of iron ore annually, and better than 250,000,000 more tons of coal every year," he said. "This presents a staggering problem in bulk materials handling in the next 10 years."

Von Thaden stated that belt conveyers in the common-carrier field were "definitely in the cards," and declared that the recent proposal for a 130-mile belt conveyer to carry ore and coal in Ohio was, in his opinion, "as practical as it is daring."

He said opponents may delay the project but predicted that they wouldn't prevent its eventual adoption. "They can't prevent progress in this field any more than the buggy-whip manufacturers prevented the automobile era," he added.

Thirteen other papers, an exhibit of time-study equipment, two luncheons, and a dinner completed the program. In charge of the conference were Don Copell, chief engineer, Wagner Baking Corporation and editor of *Modern Management*, representing the SAM, and David B. Porter, professor of industrial engineering, New York University, representing the ASME.

AT THE OIL AND GAS POWER DIVISION BANQUET HELD DURING THE 1949 OIL AND GAS POWER CONFERENCE, HOTEL SHERMAN, APRIL 25–29, 1949

(*Left to right:* James M. Todd, president ASME; R. T. Sawyer, chairman ASME Oil and Gas Power Division; and R. B. McColl, president, American Locomotive Company, Schenectady, N. Y.)

Lectures and Exhibits Featured at 21st National Oil and Gas Power Conference

CLOSE to 450 members and guests attended the 21st National Oil and Gas Power Conference of The American Society of Mechanical Engineers, held at the Hotel Sherman, Chicago, Ill., April 25–29, 1949, under the sponsorship of the Oil and Gas Power Division, with the Railroad Division and the Chicago Section co-operating. In addition to the technical sessions and inspection trips, an exhibit of engines and accessories was featured at the meeting.

Before the conference proper began, a day's program of special lectures was held, this being the third year that the Oil and Gas Power Division has sponsored such an activity. It is the purpose of these pre-conference lectures to provide for the practicing engineer an integrated course of instruction in current thought and methods in some basic field of engineering science. This year approximately 60 engineers took part in a program on gaseous fluid flow in relation to internal-combustion-engine design. Under the general direction of J. T. Rettaliata, dean, Illinois Institute of Technology, Chicago, Ill., the following lectures were presented: (1) Cooling of Spark-Ignition Engines, by Benjamin Pinkel, Lewis Flight Propulsion Laboratory, National Advisory Committee for Aeronautics; (2) Fundamentals of Air Flow in Diesel-Engine Manifolds, by W. W. Hagerty and L. Talbot, University of Michigan; (3) Reduction in Noise of Engines, by W. P. Green, Illinois Institute of Technology.

Attendance at these lectures is by invitation. The fee entitles those attending to a copy of the complete proceedings of the lecture program. It is expected that additional copies of the lectures will be available at a price yet to be established. Copies of preceding lecture series on production, physics, chemistry, and combustion of Diesel fuels, and on lubrication fundamentals, are now available from ASME Publication-Sales Department, 29 West 39th Street, New York 18, N. Y.

A total of eight papers was presented at the three technical sessions comprising the conference program. Subjects covered included: Dynamics of valve springs and valve mechanisms, two-cycle dual-fuel engines, high-frequency ignition systems for oil engines, cooling systems for Diesel locomotives, training for operation and maintenance of Diesel-electric locomotives, and engine vibrations.

Special Preprint Offer

Digests of these papers will appear in the July issue of "ASME Technical Digest." Preprints of all eight papers are currently available and may be purchased from the ASME Publication-Sales Department. Individual papers sell for 25 cents to members and 50 cents to nonmembers. The set of eight preprints may be had for $1.75 less 20 per cent to members.

Social high light of the meeting was the informal banquet, with R. Tom Sawyer, chairman of the Oil and Gas Power Division, presiding, and R. E. Friend, president of Nordberg Manufacturing Company, acting as toastmaster. The principal speaker was R. B. McColl, president of American Locomotive Company, who made a statement of the problems of American railroads, and put forward "deregulation" as a means for allowing them to realize their full potentialities of service to the nation in a free-enterprise economy. Members of the Oil and Gas Power Division were honored by the presence of James M. Todd, president ASME, who spoke briefly.

A feature of the conference was an exhibit of Diesel engines and auxiliaries composed of 47 booths which took up all available floor area of the exhibit hall of the Hotel Sherman. Considerable interest was shown in the new developments in the Diesel power field by members and guests who spent much of their free time between sessions inspecting the displays.

Special Car Provided

Close to 60 members stayed over an additional day after the close of the meeting for an all-day trip to the shops of Fairbanks, Morse, and Company, Beloit, Wis. Traveling by special car on the Chicago and Northwestern, the group arrived at Beloit about noon in time for luncheon at the plant cafeteria. The afternoon was given over to a complete inspection of the works, where Diesel engines, Diesel-electric locomotives, motors, other electrical machinery, and pumps are manufactured. The various groups returned to the cafeteria after making the inspection, to listen to brief talks on operations by executives of the company, and for informal discussion and questions relative to the processes inspected. The return to Chicago was made that evening on the Chicago and Northwestern, again in a special car reserved for members of ASME. This highly enjoyable excursion was a fitting climax to a meeting that was uniformly interesting and profitable.

Credit for the success of the meeting goes to the co-operative efforts of the executive committees of the Oil and Gas Power and Railroad Divisions, and to the officers and committees of the Chicago Section.

Reported by L. N. ROWLEY.

ASME Junior Forum

COMPILED AND EDITED BY A COMMITTEE OF JUNIOR MEMBERS, B. H. EDELSTEIN, CHAIRMAN

Two-Way Communication

THIS is the last Forum of the 1948–1949 season. When the Forum resumes in October it will be edited by an Editorial Committee headed by Robert L. Reich, Jun. ASME, who has long been interested in the professional problems of young engineers, and who has a fine record of service on many Metropolitan Junior Group committees including the Forum Editorial Committee.

Looking over its work of the year, the Forum Committee feels that it has not quite made the mark in making the Forum a two-way instrument of communication for juniors in the Regions to convey their ideas to the National Junior Committee, and the Committee to report its work to juniors far from ASME headquarters.

The Forum has attempted to stimulate self-expression among juniors by talking about it, and by communicating directly with scores of juniors in all the Regions of the Society. For some reason, juniors have been reluctant to use these few pages provided each month in MECHANICAL ENGINEERING to report and comment on the currents stirring among young engineers fresh out of college who are making important adjustments which are to set the pattern of their lives as engineers.

Good Ideas Sought

Good ideas are hard to come by, and when they blossom forth they should be given the widest circulation possible. This is especially true of ideas on how the Society can aid the young engineers coming into industry. The Council of the Society and all its administrative Boards and Committees are acutely aware that the Society must develop with the profession, must adjust its policies to provide the greatest good for all its members. On questions of policy affecting junior members, Society officers look to junior members to point the way to better service, for who, better than the juniors themselves, know intimately the obstacles to professional growth constantly being erected by aggressive union leadership, or by managements who have been tardy to note the growing stature of the engineering profession, and who are unaware of the vital need of engineers for individual consideration?

Young engineers find themselves in thousands of frustrating situations where a bit of advice, a word of encouragement, would probably clear the log jam of events which makes a future in engineering dim indeed. These situations and these events need to be cited by chapter and verse, so that they can serve as the stuff upon which future Society actions in behalf of young engineers can be based. The pages of the Forum should be the place to which Society officers could turn for case histories of what is happening to young engineers. They should be the pages, also, in which other juniors could find assurance that their own situations are not unique, and facts upon which to base a decision whether or not they should seek a more salubrious climate for their professional ambitions.

During the past year the Forum has published a few letters, but hardly enough to make the Committee feel that juniors generally are aware of the importance of these letters, or really appreciate the potentiality for good inherent in the Forum pages. Junior members are urged to look about them, to note what it is in their environment that causes dissatisfaction. If it is a lack of opportunity for professional growth, an unfriendly attitude of management to their needs, or anything which by its nature falls within the purview of a professional-engineering society, they should spell out their thinking and submit their letters for publication in the Forum. Letters should be addressed to Robert L. Reich, Akeley Camera, Inc., 175 Varick Street, New York 14, N. Y.

Members of the Editorial Committee who will be responsible for the 1949–1950 Forum are: Mr. Reich, chairman; Joseph A. Falcon, Sanderson and Porter, New York, N. Y.; Charles H. Carman, Jr., insurance broker, New York, N. Y.; Arthur J. Hughes, Babcock and Wilcox Company, New York, N. Y.; B. H. Edelstein, Works Steel Products Corporation, Bronx, N. Y.; and Robert G. Biedermann, Hazeltine Electronics Corporation, Little Neck, Long Island, N. Y., all members of the ASME Metropolitan Secion.

F. D. CARDWELL, JUN. ASME, METROPOLITAN SECTION JUNIOR PRIZE WINNER

F. D. Cardwell Wins Metropolitan Section Junior Prize

F. D. CARDWELL, Jun. ASME, research engineer with the Chemical Construction Company, New York, N. Y., won first prize in a papers competition sponsored by the Junior Group of the Metropolitan Section of The American Society of Mechanical Engineers. Mr. Cardwell's prize-winning paper, "Optimum Tube Size for Shell-and-Tube-Type Heat Exchangers," was selected from 15 papers submitted in the competition. The caliber of these papers was so high that the Selection Committee decided to select two of them for honorable mention. Glenn R. Fryling, Jun. ASME, assistant editor, Combustion Engineering-Superheater Co., Inc., won honorable mention for his paper, "Professional Adjustment—A Challenge to the Young Engineer." The other paper was "Poisson's Ratio Above the Elastic Limit," by George Gerard, Jun. ASME, instructor, Guggenheim School for Aeronautics, New York University, New York, N. Y.

Tulane Graduate

Mr. Cardwell was graduated from Tulane University in 1944 following a varied career in industry which began in 1922 when he left the University of Missouri, Columbia, Mo., before completing work for his degree in mechanical engineering. Until 1927 he was employed in the design and inspection of railway equipment. Later he was engaged in the radio and refrigerating business and was successful in merchandising household refrigeration for large apartment buildings. In 1934 he returned to his first love, mechanical design, and worked in the toy industry. With the approach of World War II he entered the shipbuilding industry, working out of New Orleans La., where he had charge of conversion of luxury liners to combat transports, and lake steamers to ocean-going cargo ships. During these years Mr. Cardwell enrolled at Tulane University on a part-time basis and taking advantage of special wartime courses, completed his work for his degree in mechanical engineering. In 1945 he joined the Chemical Construction Corporation as research engineer, working in heat transfer, fluid flow, and stress

analysis. He has developed formulas for the calculation of temperatures in a bayonet-type heat exchanger, and for the design of bellows-type expansion joints. Currently he finds time in the evenings to serve as instructor in physics at Pratt Institute, Brooklyn, N. Y.

Mr. Cardwell's paper is based on the fact that annual power cost plus fixed charges vary sharply with small changes in tube size in the tube-type heat exchangers. He developed equations involving such variables as number of tubes, length of tubes, tube size, and such fixed design factors as rate of flow in shell and heat-transfer rates. For each selected length, he points out, the total annual cost becomes a function of the diameter of tubes alone, since the number of tubes is at once determined. Hence total area, fixed charges, and power costs can be determined. By plotting curves for each chosen length, a well-defined minimum annual cost is indicated which determines the optimum tube size for the particular length.

Mr. Cardwell's method is quite flexible because, regardless of length of tube considered in the calculations, once the optimum tube diameter is found, a convenient length of tube can be selected without affecting total annual cost.

Presentation of the $25 junior prize to Mr. Cardwell was part of the ceremonies of President's Night in the Metropolitan Section. B. H. Edelstein, chairman, Metropolitan Junior Group, presided. Other honors bestowed were: Certificate of Award to H. R. Kessler, as past-chairman for two years of the Metropolitan Section; 50-year membership pins to George H. Merrill and William E. Reed; and a $10 award to Joseph G. Singer, Polytechnic Institute of Brooklyn Student Branch Evening School, for his prize-winning paper, "Influence of Sand Control on Foundry Economy," presented at the Region II Student Conference.

Following the presentation of awards, President Todd spoke on "Sulphur and Its Production." He covered the history and technical developments in the sulphur industry of the United States, impressing members with the scale of mechanical operations involved in bringing sulphur to the surface. Mr. Todd showed a film which brought out dramatically the miles of piping used, the tremendous facilities for superheating water, and other operations which spelled opportunity for the mechanical engineer. Following the President's talk, refreshments were served at which time members had a chance to meet President Todd.

300 Participate in Pittsburgh Section Mechanical-Engineering Conference

THE 1949 Mechanical-Engineering Conference sponsored annually by the Pittsburgh Section of The Amercian Society of Mechanical Engineers in co-operation with the Engineers' Society of Western Pennsylvania and the Pittsburgh Sections of the Society for the Advancement of Management and the American Materials Handling Society, brought together more than 300 engineers from the tri-state vicinity of Pittsburgh, to hear papers on materials handling in the refractories industry, production of synthetic fuels, development of aluminum impact extrusion, and other subjects.

Held at the William Penn Hotel, April 29, 1949, the conference was concluded by a banquet during which honors were bestowed on members of the ASME Pittsburgh Section. James M. Todd, president ASME, addressed the conference on "The Engineer's Contribution." President Todd said that upon the engineer falls the responsiblity of keeping the production at a level of an estimated 250 million dollars for 1949. The engineer, he said, must manufacture cheaply enough to absorb increasing taxes and pay better dividends to stockholders—must see to it that our 61 million employees are kept busy at the highest wage rates in history, and provide employment for 18 million new Americans who are to join the labor force in the next decade.

As part of the banquet ceremonies, the five following members of the Pittsburgh Section were honored: E. W. Jacobson, design engineer, Gulf Research and Development Company, was presented a Certificate of Award in recognition of his services as past-chairman of the Section; and ASME Fellow certificates were presented to the following: T. E. Purcell, vice-president ASME Region V; T. G. Estep, professor, Carnegie Institute of Technology; A. L. Nadai, consulting engineer, Westinghouse Electric Corporation, and John M. Hopwood, president, Hagen Corporation. Mr. Hopwood, who was unable to attend, was represented by R. E. Hall, Mem. ASME, director, Hall Laboratories, Inc.

Synthetic Fuels

Speaking of the production of synthetic fuels, Martin A. Elliott, U. S. Bureau of Mines, Pittsburgh, Pa., told that the U. S. synthetic-liquid-fuel potential was 2900 billion barrelss and that the country had enormous reserve, from coal, shale, and gas. Since the present annual domestic petroleum production was about two billion barrels, the country's liquid-fuel supply was assured for many years, he said. Emphasizing the magnitude of a large synthetic-fuels industry, Mr. Elliott listed the requirements for a million-barrels per day industry, or approximately one sixth of the nation's present daily consumption. Such an industry would require a capital investment of nearly nine billion dollars, an operating force of 160 thousand men, and 210 million tons of coal per year.

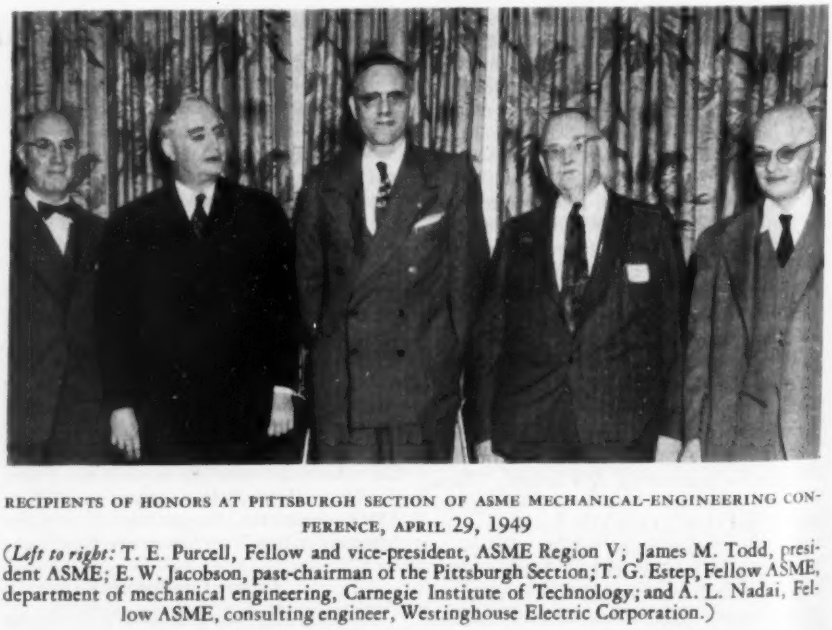
Statistical quality control, work simplification, and the benefits that can be derived from an integrated engineering organization, were subjects discussed at the management Session. Speakers were: Carl Lèvy and Phillip Lawler, student members, SAM; E. L. Schleusner, F. C. Russell Company, Cleveland, Ohio; and P. K. Shoemaker, H. J. Heinz Company, Pittsburgh, Pa.

Mechanized Mining

A new mechanical-mining machine, 29 of which are already in service, was described by W. L. Wearly, vice-president, Joy Manufacturing Company. The machine eliminated all cutting and blasting and thus contributed greatly to mine safety. According to Mr. Wearly, when properly operated with required auxiliary equipment, the machine was capable of mining as much coal in one day with a four-man team as could be mined by 56 men working by the old hand-mining methods. An account of this machine appears on pages 328–329 of the April issue of MECHANICAL ENGINEERING.

Impact Extrusion

The history of impact extrusion was reviewed from its introduction into the United States about 1870, and the present state of the art was described by R. M. Phillips of the



RECIPIENTS OF HONORS AT PITTSBURGH SECTION OF ASME MECHANICAL-ENGINEERING CONFERENCE, APRIL 29, 1949

(*Left to right:* T. E. Purcell, Fellow and vice-president, ASME Region V; James M. Todd, president ASME; E. W. Jacobson, past-chairman of the Pittsburgh Section; T. G. Estep, Fellow ASME, department of mechanical engineering, Carnegie Institute of Technology; and A. L. Nadai, Fellow ASME, consulting engineer, Westinghouse Electric Corporation.)

Edgewater Works of the Aluminum Company of America. Impact extrusion was defined as the fabrication by a single blow of mechanical press of a cuplike shell having essentially a forged bottom and extruded side walls. Mr. Phillips described the dies and punches, type of blanks, lubrication, types of presses, and variations of design of the extruded products. He said it was possible to extrude parts having other than a constant wall thickness as long as the heavier section was at the open end of the part.

Among the advantages claimed for the process by Mr. Phillips was its ability to provide a one-piece seamless construction possessing the characteristics of wrought metal. It was capable of producing certain shapes not available, or at least not available at so low a cost by other methods. Certain operations could be established on an automatic or semiautomatic basis, thus reducing production costs.

Materials Handling

Manufacture of refractory products was eminently one of materials handling in which the raw materials must be mined, transported, stored, crushed, ground, proportioned, and mixed under close control, D. B. Hendryx told the conference at its final session. Mr. Hendryx described the two principal methods of refractory-brick manufacture, the old-style periodic kiln plant and the tunnel kiln plant.

The following students also presented papers: P. F. Githens and J. A. Mosley, P. F. Lawler, and Carl Lèvy, Carnegie Institute of Technology; J. F. Coogan, University of Pittsburgh; and Robert Price, University of West Virginia.

ASME Executive Committee Actions

A MEETING of the Executive Committee of the Council was held in the rooms of the Society, April 26, 1949. There were present: James M. Todd, chairman; F. S. Blackall, Jr., Forrest Nagler, of the Executive Committee; J. H. Lawrence (Finance), K. W. Jappe, treasurer, A. R. Mumford, vice-president, and C. E. Davies, secretary.

Anti-Pollution Regulations

Upon recommendation of the Special Committee on Anti-Pollution Regulations, it was voted to authorize formation of a Committee on Air-Pollution Controls under jurisdiction of the Board on Codes and Standards, and to continue the present Smoke Law Committee of the Fuels Division on its present basis until conditions warrant other action as determined by the Committee on Air-Pollution Controls.

West Virginia Section

After considering the suggestion of the West Virginia Section that it be allowed to incorporate under laws of the state of West Virginia as a nonprofit organization, it was decided that no useful purpose could be achieved by such action.

Legacy to Society

It was noted that the ASME was one of the beneficiaries in the will of Mary E. Lewis Greene, wife of Dean Arthur M. Greene, Jr., Hon. Mem. ASME. The sum of money will be received following the death of Dr. Greene.

Appointments

The following appointments were confirmed: honorary vice-presidents as representatives of the ASME at the First International Civil Engineering Congress recently held in Mexico City, Ignacio Avilez, Alejandro del Paso, Pedro Martinez Tornel, and Carlos F. Marroquin.

Appointments on Committees and Joint Activities recommended by the Organization Committee were also approved.

Section Activities

REPORTS of the following ASME Section Meetings were received recently at Headquarters:

Baltimore, April 25. Ladies' Night dinner at The Johns Hopkins University. Guests were J. M. Todd, president ASME, and P. B. Eaton, vice-president, ASME, Region III. Professor Eaton presented a certificate to Ernest Hanhart in recognition of his services as chairman of the Section for the year 1947–1948. President Todd showed colored films of the New Orleans Mardi Gras. Professor Eaton gave a talk on his experiences in China, illustrated with a display of Chinese tapestries and samples of Chinese handiwork. Attendance: 100.

Central Indiana, April 21. Speakers: H. B. Radcliff and W. J. Hesse, winners of student-thesis competition. Subjects: Rotary Camera and Rocket Testing, respectively. Attendance: 122.

Chattanooga, April 8. Speaker: J. A. Good. Subject: Industrial Applications of Television. Attendance: 58.

Cincinnati, April 19. Speaker: J. L. Walsh. Subject: Industrial Progress Toward Peace. Attendance: 70.

Colorado, April 8. Speaker: C. J. Eckhardt, vice-president, ASME Region VIII. Subject: Engineering Success in a Changing World. Attendance: 130.

Kansas City, March 14. Speaker: L. V. Sorg. Subject: Amazing Molecules of Gasoline, illustrated with film. Attendance: 80.

April 11. Speaker: S. S. Stine. Subject: Manufacture of Jet Engines. Attendance: 95.

Milwaukee, April 20. Joint meeting with Engineers Society of Milwaukee. Speaker: R. L. Lee. Subject: Engineering, Man to Man. Attendance: 200.

Nebraska, April 1. Stag party sponsored by Wray M. Scott and held at his plant. All Nebraska sections of the national engineering societies, and the Omaha Engineers Club participated. Demonstration of bending and testing of large pipe, and showing of a Babcock-Wilcox film on steam. Attendance: 132.

New Orleans, April 7. Joint meeting with ASME student branch, Tulane University. Attendance: 89.

Philadelphia, April 26. Speakers: M. J. Leonard and C. Bary. Subjects: Principles of Heat-Pump Operations and Residential Heat Pumps, respectively. Attendance: 141.

Schenectady, April 21. Joint meeting with Rensselaer Polytechnic Institute student branch. Speaker: H. B. Hansteen. Subject: Nuclear Energy and Its Applications. Attendance: 110.

South Texas, Junior Group, April 14. Speaker: G. H. Johnson. Subject: Offshore Drilling Operations illustrated with technicolor film. Attendance: 45.

ASME Sections

Coming Meetings

Anthracite-Lehigh Valley: June 24. Not determined (Section Meeting).

Atlanta: June 10. East Lake Country Club. Cocktails, dinner, and dancing at 6 p.m. A. C. White in charge of program.

Minnesota: June 1. Annual University Night and Student Awards dinner. Speaker to be announced.

Peninsula: June. A general outing

San Diego Sub-Section (Southern California Section): June 15. San Diego Women's Club. Open Forum: Technical Subjects. Chairman: M. G. Northrup.

June 29. Inspection trip through the new San Diego Sewage Disposal and Treatment Plant. Conductor: E. R. Prout.

Southern California: June 1. Professional Division, 601 West 5th St., Los Angeles. Subject: 1950 Section Activities, by J. S. Earhart.

June 1. Hydraulic Division, California Institute of Technology, Pasadena. Subject: Automatic Control Valves, by R. E. Hemborg.

June 8. Photographic Division, 955 North Mansfield Ave., Hollywood. Subject: Manufacturing and Application of Varitron Camera, by J. Beattie.

June 8. Steam Power Division, 601 West 5th St., Los Angeles. Subject: Steam Power-Plant Problems, by R. E. Barton.

June 8. Management Division, Alexandria Hotel, Los Angeles. Dinner at 7 p.m. Subject: Administrative Policies, by E. Favary.

June 8. Hydraulic Division, California Institute of Technology, Pasadena. Subject: Pump-Installation Design, by P. Brown.

June 10. Materials Handling Division, Long Beach Harbor tour, Pier Point Landing. Speaker: A. K. Maddy.

June 15. Hydraulic Division, California Institute of Technology, Pasadena. Subject: Process and Refinery Piping, by A. H. Alexander.

June 16. Heat-Transfer Division meeting. 8 p.m. California Aeronautical Institute, Glendale, Calif. Subject: Heat-Transfer Problem in Liquid-Propellent Rocket. Speaker: R. Gordon.

June 17. Production Engineering Division, Ontario Works of General Electric Company, field trip, conducted by F. E. Finlayson.

June 22. Hydraulic Division, California Institute of Technology, Pasadena. Subject: Hydraulic Circuits, by F. Mattell.

June 22. General Division, Mayfair Hotel, Los Angeles. Registration. Welcome by J. Calvin Brown.

June 22 to 24. Heat Transfer and Fluid Mechanics Division, University of California, Berkeley. Subject: Annual Institute, Presentation 22 papers.

June 23. Field trips: As selected by guests en route to San Francisco Semi-Annual Meeting.

June 24. Field trips: As selected by guests en route to San Francisco Semi-Annual Meeting.

June 29. Hydraulic Division, California Institute of Technology, Pasadena. Subject: Writing of Engineering and Construction Specifications, by A. Hunter.

June 27–30. Semi-Annual National Meeting, San Francisco.

Youngstown: June. Annual Picnic.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which operates in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3.50 per quarter or $12 per annum, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	84 East Randolph Street	100 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

MECHANICAL ENGINEER, graduate, BME, 32, single, desires position with industrial firm not requiring specialized experience. Has mechanical aptitude, writing ability, experience in mechanical inspection. Willing to travel. Immediately available. Me-416.

MECHANICAL ENGINEER, 26, BSME, PG, IE. Two years' experience gas-production and power-plant construction administration. Prefers operation or production work in manufacturing field. Presently residing New York, Will relocate northeast United States. Me-417.

MECHANICAL, CHIEF OR DEVELOPMENT ENGINEER with long experience in design and development in hydraulics, printing and binding, valves, and engineering specialties. Middle or Southwest. Graduate University of Illinois. Me-418.

ASSISTANT TO PLANT MANAGER OR TO PLANT ENGINEER, mechanical graduate, PE license. Metalworking, research, production control, administration, supervision, cost studies, reports, government contracting, plant surveys, steam-power plants. Me-419.

MECHANICAL ENGINEER, 28, BS, married; two and a half years project engineering of electromechanical equipment, two and a half years manufacturing planning of telephone cable, a year of naval-machinery design. Will relocate. Me-420.

MECHANICAL ENGINEER, graduate, June, 1949, BME, NYU. Single. Desires position with future in design and development. Willing to work anywhere in the U. S. Me-421.

PLANT OR PRODUCTION ENGINEER, 30, ME graduate, married. Seven years' supervisory experience in operation, production, cost analysis, plant maintenance and design, job estimating, and industrial-plant construction. Desires permanent position in U. S. A. Me-422.

MECHANICAL ENGINEER, over 20 years' supervisory experience in machine design and development; well-grounded in all phases of precision manufacture desires responsible position in the east. Me-423.

INDUSTRIAL ENGINEER, 26, BME. Three years' experience. Managed a manufacturing plant. Successful record in production, company-union negotiations, time study, methods, and setting up production lines. Willing to travel. Me-424.

RECENT GRADUATE, 23, BSME, June 1949. University of Connecticut. Summer experience in design. Interested in design, power work, or production. Location immaterial, will consider foreign employment. Me-425.

EXECUTIVE OR ADMINISTRATIVE ASSISTANT. Mechanical engineer, 48. Diversified experience in utility and manufacturing management including operation, production, standard costs, controls, planning. Large or small company. Me-426.

PROFESSOR of applied mechanics for courses in dynamics, vibrations, stress analysis, elasticity, ductility, theory of stability, plates and sheets, machine design, etc. Twenty years' experience teaching and industrial research. Me-427.

RECENT GRADUATE, mechanical engineer, 25, married, with extensive electrical-control background, and experience in maintenance, desires challenging position. Will accept position anywhere in U. S., or foreign country if wife can accompany. Me-428.

STAFF EXECUTIVE, ten years' comprehensive experience in manufacturing, engineering, administration, and top-management planning and control. Registered industrial engineer. Mechanical-engineering degree and graduate work in business administration. Me-429.

EFFICIENCY POWER-PLANT ENGINEER, 23, single, BSME, plus operating certificates. Studying for master's degree in industrial engineering. Experience in testing equipment, water treatment, preparing operating reports, instrument maintenance. New York-New Jersey area. Me-430.

MECHANICAL ENGINEER, 35, married, with thirteen years' experience including eight years developing aircraft, hydraulic, and pneumatic equipment, three years' experience with industrial automatic controls. Desires responsible position. California or eastern United States. Me-431-458-D-7.

MECHANICAL ENGINEER, 27, single, six years' experience in design and application of heavy equipment, piping, machine-shop practice, rotary and special handling equipment, etc. Desires position of design or administrative nature. Me-432.

POSITIONS AVAILABLE

FOUNDRY SALES MANAGER, not over 45, with gray-malleable and steel-foundry experience, and background in metallurgical or mechanical engineering for Midwestern production foundry. $12,000-$16,000. Y-2342.

ASSISTANT WORKS MANAGER, 35–45, engineering graduate, with heavy-machinery production experience, including broad job-shop practice, to take charge of methods, time study, controls, materials handling, heat-treatment, inspection, laboratories, etc. $7200-$8400. New York metroplitan area. Y-2348.

MECHANICAL ENGINEER, graduate with several years' experience in chemical-plant engineering (not pilot plant). Duties will include design, layout, and engineering supervision of field work. $4500. West Virginia. Y-2350.

PLANT ENGINEER to take charge of maintenance and operations of three sugar mills. Knowledge of steam power plants desirable. Experience in Latin-American countries. Must speak Spanish. $10,000. Cuba. Y-2361.

GENERAL MANAGER, 40–50, engineering graduate, with broad experience on electromechanical devices, to take charge of precision aircraft products plant. $10,000-$12,000. Northern New England. Y-2376.

ENGINEERS. (*a*) Manufacturing engineer, 38–50, preferably mechanical graduate, with several years' experience in designing tools, or equipment, processing, or estimating, machine-shop and sheet-metal fabricated items. Experience in time study, wage-rate work, etc. Work will include tooling, processing, and methods, equipment, facilities, plant layout, etc. (*b*) Materials engineer, 32–45, preferably industrial-engineering graduate. Should

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[1] All men listed hold some form of ASME membership.

know technique of scheduling work through a factory. Should know procedures of requisitions and scheduling purchased materials into a manufacturing plant, etc. Should be able to evaluate information in such a way as to forecast market trends. Duties will include planning and scheduling, inventory control and movement of materials. (c) Plant manager 35–45, mechanical, electrical, refrigeration, or industrial graduate, with several years' experience in management of an industrial-manufacturing operation with both process and mechanical features large enough to have provided real responsibility and broad industrial experience. Some experience with punch press, brake, welding, general machine shop, painting, assembly, plant maintenance, or toolroom operation. Experience in plant management including all phases of administration. Ability to achieve high quality at low cost. $9000–$10,000. New Jersey. Y-2414.

Designers-Draftsmen, mechanical, for layout of steam-piping systems and conveyers. Should have at least five years' experience in large high-pressure steam power plants. $5200. Pennsylvania. R-5264(b).

Designer (assistant chief engineer) mechanical graduate, experienced with intricate precision machinery, preferably with Diesel experience. Should be sound mathematically, and have knowledge of hydraulic controls. Will engage in design of fuel-injection pumps for a manufacturer. $7200. Illinois. R-5619.

Chief Engineer (design) mechanical background, with ten to fifteen years' experience in machine design. Will supervise engineering department of three engineers and three draftsmen for a manufacturer of steel and sheet-fabricating machinery. $7000. Illinois. R-5624.

Project Engineer, mechanical, experienced in building-construction field, capable of independently handling all phases of design, specification writing, and supervision of heating, ventilating, air conditioning, plumbing, and electrical installations in connection with design and erection of university building campus. Salary open. Illinois. R-5632.

Estimator, (boiler setting) mechanical backround, completely informed regarding use of unit cost and job estimation as applied to refractories used in boiler construction and setting. Will be concerned with plastic refractories as opposed to tile and firebrick setting for an international company which controls operations from mining through manufacturing materials, engineering work, construction, and boiler setting. Salary open. Illinois. R-5653.

Designers (machine tool) mechanical background. Will be engaged in high-power precision horizontal boring, drilling, and milling machines, a precision product in the heavy-machine-tool field for a manufacturer of table, planer, and floor types in all sizes. Salary open. Midwest. R-5656.

Industrial-Methods Engineer, graduate, with proved ability for job-shop operation. Must possess a background to establish work and cost standards, and procedure. A college degree and ten years' practical experience is a prerequisite. Salary commensurate with ability. Illinois. R-5662.

Candidates for Membership and Transfer in the ASME

The application of each of the candidates listed below is to be voted on after June 25, 1949, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election: Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

Aaron, Francis J., Sharon, Pa.
Adams, Leo, Brooklyn, N. Y.
Allen, Frank J., York, Pa.
Andrews, William, Houston, Texas
Baynham, Robert S., Portland, Ore.
Beare, Gene K., Chicago, Ill.
Bell, Charles O., Chattanooga, Tenn.
Birnberg, Zingel C., Youngstown, Ohio
Block, Donald L., Girard, Ohio
Boyd, Orby C., Aurora, Ill.
Brown, Howard F., Waukegan, Ill.
Brozek, John S., West Haven, Conn.
Carothers, T. E., Los Angeles, Calif.
Christman, William J., Williamsport, Pa.
Cody, William F., Chicago, Ill.
Cooper, William E., W. Lafayette, Ind.
Corizzo, Vincent P., Brooklyn, N. Y.
Curt, K., Zurich, Switzerland
Danyluke, Ostap, Philadelphia, Pa.
Davis, O. B., Charleston, W. Va.
Davis, Ralph C., Chicago, Ill.
Decker, William H., Whiting, Ind.
Demirjian, George, Schenectady, N. Y.
Dexter, Robert Gordon, Boston, Mass.
Dickey, Clarence E., Sterlington, La.
Diehl, George S., Lancaster, Pa.
Dietz, Charles E., Newark, N. J.
Dixon, Lloyd A., Jr., DuBois, Pa.
Dixon, Troy R., Los Angeles, Calif.
Doerr, Robert Edwin, New Haven, Conn.
Drinker, Pemberton H., Philadelphia, Pa.
Ednie, Robert Lewis, Baton Rouge, La.
Edwards, William H., Rumson, N. J.
Ellis, Robert M., Kansas City, Mo.
Falster, Hans, Honolulu, Hawaii
Farquhar, Harold F., Wilmington, Ohio
Ferguson, Douglas E., Kansas City, Mo.
Fernandez, John P., New Orleans, La.
Finck, Paul A., St. Charles, Mo.
Firth, Cyril, Youngstown, Ohio
Flanigan, Frank McChesney, Gainesville, Fla.
Floden, John G., Rockford, Ill.
Fortune, J. R., Jr., Detroit, Mich.
Gartland, Wm. Lincoln, Youngstown, Ohio
Gordon, Mason L., Los Angeles, Calif.
Graf, Francis E., Birmingham, Ala.
Griffin, Dudley E., Tulsa, Okla.
Grover, Allen C., San Francisco, Calif.
Head, George W., Jr., Macon, Ga.
Hillman, Albert, Brooklyn, N. Y.
Hinojosa, O. N., Chicago, Ill.
Hirschfield, Fritz Daniel, Chicago, Ill.
Holdhusen, James S., Minneapolis, Minn.
Holmes, Harry R., Manhattan, Kan.
Hoover, Merle L., Morgantown, W. Va.
Hosokawa, William T., Cleveland, Ohio
Hughlett, Lloyd J., New York, N. Y.
Jacobs, Mifflin S., Pittsburgh, Pa.
James, Charles C., New York, N. Y.
Johnson, Sidney P., San Francisco, Calif.
Jones, G. Randolph, Leaside, Ont., Can.
Kannianinen, H. A., St. Albans, W. Va.
Kaufman, Everett S., Elizabeth, N. J.
Keating, Pierce V., Chicago, Ill.
Kern, Kenneth C., Los Angeles, Calif.
Kirkland, W. G., Huntington Park, Calif.
Kramer, R. J., Jr., Columbus, Ohio
Kubster, Carl A., Baldwin, N. Y.
Lemos, Albert J., Hinsdale, Ill.
Livera, Paul, Newark, N. J.
Lombard, Daniel, Youngstown, Ohio
Malach, Kenneth W., Baltimore, Md.
Mannio, Pekka, Helsinki, Finland
Marquardt, R. I., Portland, Ore.
Marucci, Salvador, Bronx, N. Y.
Mattison, Arthur M., Jr., Rockford, Ill.
Maxfield, C. N., San Francisco, Calif.
McDowell, L. D., Chicago, Ill.
McKissock, George D., Gainesville, Fla.
McKnight, George W., Philadelphia, Pa.
Mellow, George E., St. Louis, Mo.
Mills, Donald C., Youngstown, Ohio
Murray, C. R., Park Ridge, Ill.
Myers, Ivan G., Everett, Wash.
Nilsson, Einar W., Youngstown, Ohio
O'Connell, Patrick W., Royal Oak, Mich.
Parsons, C. W. S., Beverly Hills, Calif.
Penichet, F. M., New York, N. Y.
Perkins, Origen S., Hales Corners, Wis.
Quinn, George Clemence, Jr., San Francisco, Calif.
Rappaport, Sigmund, Durham, N. C.
Rencher, Edwin R., Jr., Mobile, Ala.
Riggs, Orval W., Michigan City, Ind.
Roberts, Edward A., Pullman, Wash.
Rotter, John, Passaic, N. J.
Rozycki, Raymond V., Cloquet, Minn.
Rudkin, Donald A., Linden, N. J.
Ruffin, Jay B., New Orleans, La.
Rule, Bruce H., Pasadena, Calif.
Saksena, G. B., London, England
Schumann, Charles P., El Segundo, Calif.
Semler, Robert Chas., Phillipsburg, N. J.
Senkus, Walter F., Chicago, Ill.
Shaw, Charles Gordon, Vancouver, B. C., Can.
Shaw, Haylett B., Pittsburgh, Pa.
Sheffield, Milton B., Lombard, Ill.
Shroff, E. R., Bhaunagar Para, Kathiawar India
Sidey, James E., Portland, Ore.
Smith, F. Bernard, Philadelphia, Pa.
Solomon, William J., Youngstown, Ohio
Stormont, R. J., Saginaw, Mich.
Strasser, John D., El Cerrito, Calif.
Swanson, Ernest N., Cranston, R. I.
Swanton, Deane M., New York, N. Y.

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SWEENEY, EDGAR J., Phoenix, Ariz.
TAYLER, F. E., JR., Grosse Pointe, Mich.
TAYLOR, GEORGE W., Oak Ridge, Tenn.
THOREL, J. P., Baltimore, Md.
TONG, ROBERT W., Nottingham, England
ULLMANN, JOHN E., Forest Hills, N. Y.
VAN ASSELT, HAROLD, Grand Rapids, Mich.
VAUGHAN, AUBREY W., JR., Seattle, Wash.
WALTER, H. K., Corner Brook, Newfoundland
WANDERER, EDWARD T., New Kensington, Pa.
WATT, JOHN W., Chicago, Ill.
WERNER, O. W., Pittsburgh, Pa.
WITCHER, THOMAS H., Falls Church, Va.
WRIGHT, F. S., Kingsport, Tenn.

CHANGE IN GRADING

Transfer to Member

ANDRES, W. A., Minneapolis, Minn.
BOETTIGER, RUSSELL WM., Glen Ridge, N. J.
DAY, EMMETT ELBERT, Seattle, Wash.
HODGKINSON, GEORGE A., Newark, N. J.
IRWIN, JOHN S., Yonkers, N. Y.
LINDQUIST, ELMO G., Sandwich, Ill.
LUSK, JAMES B., W. Lafayette, Ind.
MARQUIS, DONALD HALL, Schenectady, N. Y.
MCCHESNEY, IRVIN G., Rochester, N. Y.
MITCHELL, WILLIAM FISH, Philadephia, Pa.
MUELLER, LESTER A., Dallas, Texas
PHILLIPS, HENRY W., New York, N. Y.
SANDORFF, PAUL E., Burbank, Calif.
WEIDNER, CARL BIRCH, Shreveport, La.
WOOD, ERNEST P., Webster Groves, Mo.

Transfers from Student Member to Junior 400

Obituaries

Bertrand Robson Torsey Collins (1866–1949)

BERTRAND R. T. COLLINS, retired mechanical engineer, died March 3, 1949, at his home in Princeton, N. J., following a lengthy illness. Born, York, Me., Nov. 10, 1866. Parents, Rev. John and Laura Smith (Horne) Collins. Education, Fryeburg (Me.) Academy; BS, Massachusetts Institute of Technology, 1888. Married Katherine Greer, 1900. Jun. ASME, 1891; Mem. ASME, 1901; Fellow ASME, 1947. Served on Power Test Codes, Complete Steam Power Plants Committee No. 11, 1925–1930. Survived by his wife and three daughters, Dorothea, Princeton, N. J., Mrs. Elden C. Mayer, Beaver Dam, Wis., and Mrs. James R. Hughes, Utica, N. Y.; a sister, Viola T. Collins, Waldo, Fla.; and three grandchildren.

Fred Brainard Corey (1869–1949)

FRED B. COREY, retired mechanical and electrical engineer, died March 20, 1949. His home, Stony Knoll, was in Barberton, Ohio. Born, Homer, N. Y., Sept. 28, 1869. Parents, David Brainard and Frances M. (Benedict) Corey. Education, Homer (N. Y.) Academy; ME, Cornell University, 1892. Married Caroline L. Heberd, 1894, who died in 1932; children, Dr. Robert B., and Dr. Edward L. Corey. Jun. ASME, 1894; Mem. ASME, 1900.

Alvin Bartholomew Einig (1884–1949)

ALVIN B. EINIG, general manager and director, Motch and Merryweather Machinery Co., Cleveland, Ohio, died at St. Vincent's Hospital, Cleveland, Ohio, Feb. 27, 1949. Born, Defiance, Ohio, Aug. 9, 1884. Parents, Macey Bartholomew and Julia (Reedy) Einig. Education, BSME, Case Institute of Technology, 1907. Jun. ASME, 1912; Assoc. ASME, 1921; Mem. ASME, 1935. Served on the Executive Committee, Cleveland Section, 1940–1941. He was unmarried. Survived by his mother and a sister, Mrs. Willam H. Keller, Canton, Ohio; and two nephews, Dr. Karl W. Keller, Canton, Ohio, and Walter T. Einig, Atlanta, Ga.

Clarence Raymond Green (1916–1949)

CLARENCE R. GREEN, engineering assistant, mechanical-production department, The Detroit Edison Co., Detroit, Mich., died of progressive spinomuscular atrophy Jan. 20, 1949, after a lengthy illness. Born, Ann Arbor, Mich., June 6, 1916. Parents, Raymond A. and Fannie (Thompson) Green. Education, BSE, University of Michigan, 1937. Married Agnes Steere, 1939. Jun. ASME, 1937. Survived by wife and three sons, Raymond C., James R., and George E.

Hiram A. Holzer (1876–1949)

HIRAM A. HOLZER, president, United Iron Works Co., Pittsburg, Kan., died March 27, 1949. Born, Girard, Kan., in 1876. Parents, Charles August and Emma Estella (Adsit) Holzer. Education, BSME, Kansas State Agricultural College, 1899. Married Bessie May Bever, 1901, by whom he is survived. They had no children. Mem. ASME, 1921.

Alexander Grant McGregor (1880–1949)

A. GRANT MCGREGOR, consulting mechanical engineer to the Chester Beatty Group of Mining Companies, London, England, since 1927, died March 4, 1949. Born, Raymond, Kan., March 1, 1880. Parents, Donald and Ada A. (Cole) McGregor. Education, BSME, University of Montana, 1902. Married Beula M. Morgan, 1905; children, Grant Morgan, Donald Thomas, John Porter, and James Bennett. Married 2nd, Harriet Rankin Sedman, 1935. During World War II he was consulting engineer to British Ministry of Aircraft Production and to Nonferrous Mineral Development Control. Jun. ASME, 1905; Mem. ASME, 1912.

Rupert Chester Perry (1882–1948)

RUPERT C. PERRY, mechanical engineer, U. S. Time Corp., Middlebury, Conn., died Nov. 27, 1948, at his home in Waterbury, Conn. Born, Brookfield, Conn., May 19, 1882. Parents, Theodore and Frances (Osborne) Perry. Education, Curtis Academy; the American School of Correspondence; and supplementary courses. Married Jessie Wakem, 1903, who survives him. They had no children. Assoc. ASME, 1921; Mem. ASME, 1935.

Edward Arthur Robinson (1881–1949)

EDWARD ARTHUR ROBINSON, consulting engineer, Portland, Ore., died Feb. 14, 1949. Born, Dayton, Ohio, June 14, 1881. Education, Boise (Idaho) High School; one year, University of Oregon. Mem. ASME, 1941.

Walter Cooper Sanders (1893–1949)

WALTER COOPER SANDERS, general manager, railroad division, Timken Roller Bearing Co., Canton, Ohio, died Feb. 13, 1949. Born, Cedartown, Ga., Feb. 4, 1893. Parents, Joel Harris and Ora (Sewell) Sanders. Education, Cedartown (Ga.) public schools; Mercer University, 1915. Married Margaret Elizabeth Taggart, 1928; children, Walter C., Jr., and James T. Jun. ASME, 1917; Assoc. ASME, 1920; Mem. ASME, 1935; Fellow ASME, 1947.

John Stadler (1874–1948)

JOHN STADLER, member of the firm of Stadler, Hurter and Co., Montreal, Canada, died in March, 1948. Born in Bavaria, Germany, April 2, 1874. Education, diploma in engineering, Polytechnic Institutes of Munich and Mittweide, Germany. Mem. ASME, 1920.

Stanley Strenger (1918–1949)

STANLEY STRENGER, engineer, and a partner in the building concern of Joseph Strenger and Son, Bronx, N. Y., died at the Manhattan General Hospital, New York, N. Y., March 15, 1949. Born, New York, N. Y., Dec. 7, 1918. Parents, Joseph and Lina (Kalmus) Strenger. Education, AB, Columbia University, 1939; BS, Columbia University, 1940; MME, New York University, 1943. Member Phi Beta Kappa and Tau Beta Pi. Married Bette Kaplan, 1942. Jun. ASME, 1943. Survived by his wife and two children, Holly and Laurie; and his father, Joseph Strenger, with whom he was associated in business.

William Henry Wilson (1891–1948)

WILLIAM HENRY WILSON, mechanical engineer and owner of the Chattanooga Button and Badge Manufacturing Co., died at his home in Chattanooga, Tenn., Dec. 23, 1948. Born, Louisville, Ky., Dec. 7, 1891. Parents, William Henry and Rosalind (Holland) Wilson. Education, public schools of Louisville; ICS; and extension courses, University of Wisconsin. Married Constance Massey, 1913. Mem. ASME, 1941. Survived by his wife and daughter, Mrs. Noel C. Hunt, Jr., of Chattanooga, Tenn.

Albert Carroll Wood (1874–1949)

ALBERT C. WOOD, consulting engineer, died in his home at Philadelphia, Pa., March 13, 1949, of a coronary occlusion. Born, Fayetteville, Ark., Feb. 21, 1874. Parents, Harvey Doak and Annette (Dickerson) Wood. Education, BSME, University of Arkansas, 1892. Married Anna Sarah Powell, 1911. Received an honorary DS degree, University of Arkansas, 1943. Jun. ASME, 1894; Assoc. ASME, 1900; Mem. ASME, 1904; Fellow ASME, 1943. Served on Power Test Codes Technical Committee on Definitions and Values, 1945; Committee on Manual of Practice, 1947. Survived by wife; they had no children.

Augustus Wood (1869–1948)

AUGUSTUS WOOD, retired consulting engineer, died in 1948. Born, Batavia, N. Y., Jan. 29, 1869. Parents, Edward F. and Mary J. (Jumphery) Wood. Education, ME, Cornell University, 1891. Married Grace E. Cole, 1902; children, Frederick C., Robert B., and Charles Cole. Mem. ASME, 1901.